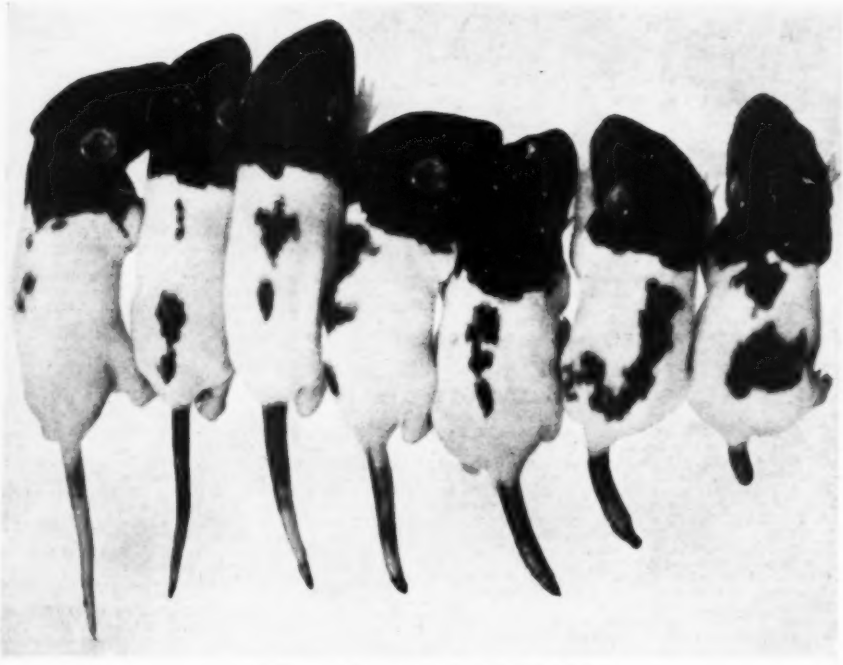
PEARL

The Journal of HEREDITY



SHORT TAILS OF THE RAT
(SEE PAGE 123)

Marriage Counselling in Europe
An Explanation of "Progressive Heredity"
Dental Defects Associated with Dysostosis
Genetics of Fragrance in the Gladiolus
Plans for Seventh Genetics Congress
The Inheritance of Jaundice

VOLUME 29 APRIL, 1938 NUMBER 4

THE LIFE, LETTERS AND LABOURS OF

FRANCIS GALTON

BY KARL PEARSON

Four large volumes (11 in. by 8 in.)
182 full-page plates, some in color.

Previously $59.40—Now $39.00

THIS magnificent biography by one great man of science about another, has been compared with Boswell's Johnson and Trevelyan's Macaulay. It is a full record of a life of amazing diversity, luxuriously printed by the Cambridge University Press. Galton's pioneering work in biometry, psychology, anthropology, genetics, eugenics and human biology to a large extent constitutes the source of our modern interest in these subjects, so important to the future of the race. Here is an account in good measure of the man's many-sided activities and of his speculations on everything with which he came in touch.

The books contain much material tracing the heredity of the Galton and Darwin families. These volumes are of absorbing interest to any scientist, and particularly to any student of heredity.

"It was certainly fitting that the life of the greatest exponent of heredity should be written by his great disciple, and it is gratifying indeed to find that he has made of it what may without exaggeration be termed a great book."

—DAILY TELEGRAPH

"A wholly worthy memorial of a very great man."

—SCIENCE

Readers of "The Journal of Heredity" are particularly invited to take advantage of the reduced price.

CAMBRIDGE UNIVERSITY PRESS

The Macmillan Company, 60 Fifth Avenue, New York

The

Journal of Heredity

Vol. XXIX APRIL, 1938 No 4

Contents

DOUBLE FACTORS FOR FRAGRANCE IN THE GLADIOLUS
By Forman T. McLean 115

SPONTANEOUS TAIL AMPUTATION IN THE NORWAY RAT
By G. W. Wooley and L. J. Cole 123

DENTAL ABNORMALITIES IN CLEIDO-CRANIAL DYSOSTOSIS
By Martin A. Rushton 129

HEREDITARY ACHOLURIC JAUNDICE IN THE RAT
By C. H. Gunn 137

"PROGRESSIVE HEREDITY" AND "ANTICIPATION"
By Richard Goldschmidt 140

FIVE GENERATIONS OF SHORT FINGERS
By Mable R. Walter 143

THE INHERITANCE OF DEW CLAWS IN THE DOG
By Clyde E. Keeler and Harry C. Trimble 145

PICTA PATTERNING IN PHLOX
By J. P. Kelly 149

MARRIAGE COUNSELLING IN EUROPEAN COUNTRIES
By Marie E. Kopp 153

Reviews and Notes

EVOLUTION AND GENETICS (Rev. of SCHINDEWOLF, *Palaontologie*, etc.) 122
U. S. POPULATION GROWTH 127
TEACHER = KIBITZER — ? *By Edwin E. Jacobs* 128
GENETICS CONGRESS PLANS 135
ANISFIELD AWARD TO ELIN ANDERSON 144
OUR TWO INHERITANCES 152
SPECIES HYBRIDS IN SUGAR-CANE 160

The JOURNAL OF HEREDITY is published monthly by the AMERICAN GENETIC ASSOCIATION at 32nd Street and Elm Avenue, Baltimore, Md., and Victor Building, Washington, D. C. Address all communications regarding editorial matters to Room 308, Victor Building, Washington, D. C. Communications regarding the business management of The JOURNAL OF HEREDITY may be addressed to the publication office, 32nd Street and Elm Avenue, Baltimore, Md., or to the Victor Building, Washington, D. C. Entered as second class matter February 24, 1923, at the postoffice at Baltimore, Maryland. Acceptance for mailing at the spepcial rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 20, 1918. Contents copyrighted 1938 by the American Genetic Association. Unauthorized reproduction of material from THE JOURNAL not permitted. The title "Journal of Heredity" is registered as a trade-mark in the U. S. Patent Office. $3.00 a Year. 35c the Copy for the current issue. Prices on back numbers on application.

$3.50 a Year ***35c. the Copy***

WILLIAM HERBERT'S "GLADIOLUS FRAGRANS'

Frontispiece

Vase of first-generation hybrids between *Gladiolus tristis* and *G. recurvus*, two fragrant species related to the garden gladiolus. They are very different in respect to odor,—tristis having a lily-like scent at night, while recurvus has a mild violet-like scent during the day. All of the first generation hybrids have the violet fragrance of *G. recurvus*, but lack the tristis fragrance, though it reappears in some of the seedlings in the second and later generations. This cross was made over a hundred years ago by Dean William Herbert, one of the great hybridists of the early nincteenth century, who called the hybrid *Fragrans*. The hybrid was propagated for a time, but eventually disappeared. One-third natural size.

DOUBLE FACTORS FOR FRAGRANCE IN THE GLADIOLUS

FORMAN T. MCLEAN

WHEN this project, to put fragrance into the race of the garden gladiolus, was started fifteen years ago[6,7,8], about a half dozen fragrant wild species of the genus were known from South Africa; all slender, delicate, winter-growing forms, more resembling the greenhouse freesia than the gladiolus as we know it. The dream of a stately gladiolus with fragrance added was not new. One of the wild fragrant species, *Gladiolus tristis,* is grown as a curiosity and to some extent commercially in England and Holland; and gladiolus breeders have tried sporadically for an hundred years to get its powerful but elusive night fragrance into more acceptable garden gladioli. The crossing of tristis with garden varieties proved easy, but the results were highly discouraging. The hybrids were small, sterile mules,—and scentless.

So the problem is a two-fold one; to find or produce a fertile fragrant race of gladioli, that will transmit fragrance to hybrids between it and scentless garden varieties; and next to develop acceptable garden hybrids with fragrance. At the start, three fragrant species were available: (1) *Gladiolus tristis,* the little, slender greenish-cream colored, night-scented Avondbloem of the Boers; (2) the closely related *G. grandis,* the Brown Afrikander; and (3) *G. recurvus,* the Mauve Afrikander, which has a mild, violet-like day fragrance, and narrow little flowers, greenish-cream to lavender or purple speckled. Of these, *G. tristis* had already been crossed with garden varieties without success; *G. grandis* proved to be similar, but inferior as a parent; and *G. recurvus* failed to cross with the scentless garden sorts. Thus the direct attack on the problem failed as the crossing of fragrant species with garden varieties did not eventuate in any fragrant hybrids.

There still remained the possibility of building up a fragrant hybrid race from fragrant species, hoping that the hybrids would, like *G. tristis,* cross with the garden sorts, and unlike that species, might transmit fragrance to the resulting progeny. The best prospect seemed to be a cross between *G. tristis* and *G. recurvus.* This same cross was made by Dean Wm. Herbert, of Manchester, England,[4] over an hundred years ago, and he called his hybrid *Gladiolus fragrans,* which was encouraging for the present purpose; but he apparently did nothing further with them, being more concerned with other brighter colored hybrids. None of his *G. fragrans* appear to have persisted beyond the middle of the last century.

In the present study this cross was repeated and the hybrids interbred, to learn the manner of inheritance of fragrance and of such other species traits as might prove to be a benefit or a hinderance in hybridizing with the garden sorts for fragrance. While the purpose was candidly a practical one, — to produce acceptable fragrant hybrid gladioli, — because of the hundred years of failure in similar efforts by others, a detailed study was deemed necessary. The results appear to justify this procedure, as well from a practical as from a scientific standpoint.

Crosses were made using as seed parent one clon of the wild species here designated Tristis II, pollinated by two clons of the other wild species, called respectively Recurvus Bronze and Recurvus Violet Purple. The records of the progeny of the two groups were kept distinct. This was necessary, since both species studied are quite variable in color and markings, though constant in their diagnostic characters, which include flower fragrance. Then the F_1 hybrids from Recurvus Bronze were inter-

crossed, and also backcrossed with Tristis II. In all 2,200 hybrids were studied in some detail, recording not only their fragrance, but 23 other characteristics, to learn if these might be linked to fragrance and prove beneficial or detrimental in the subsequent hybrids which it was expected to use with the garden varieties.

Noses Different

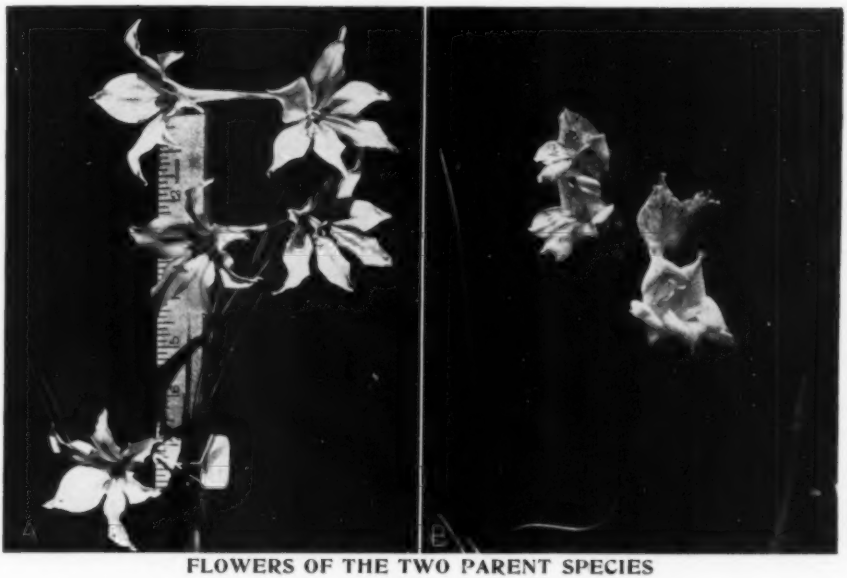
The study of the inheritance of fragrance was beset with problems from the start. First, there were no clear-cut standards for measuring fragrance. We must depend upon our noses. Then, individual noses record widely different results, as Dr. A. F. Blakeslee has recently emphasized.[2] All of the observations of fragrance and of other traits used in this study were made by the writer, with the help of two coworkers, Miss Lunt and Mrs. Jennison, whose perceptions of fragrance tallied very well with his. A notable fact, that stood out whenever other people were called in to test the flower fragrance, was that tobacco smokers quite regularly had less sensitive noses than non-smokers. The writer is not a smoker, which may be one good reason for his undertaking this particular study. Even so, the results are presented only as the perceptions of one nose, and this will account for the rather consistent findings. It was evident throughout the study that any attempt to have averaged the observations of even a large number of people would have been unsatisfactory, individual variations in perception of fragrance being too great.

To show the mechanism of inheritance of fragrance in these hybrids, the observations of fragrance in the two groups of F_1 hybrids, in the F_2, and in the backcross to Tristis II are summarized in Table I. The fragrance is tabulated under eight items. First comes Non-fragrant, of which there were a surprising number in the F_2 and the backcross, considering both species are consistently fragrant. The simplest explanation of the Non-fragrant (Line 1) F_2 and backcross individuals is to assume that there are non-fragrant allelomorphic factors to those for violet-like Recurvus day fragrance (Line 2), and for the lily-like Tristis night fragrance (Line 4). Since both scents are combined in some individuals (Line 3), the two scents cannot be themselves allelomorphic. It is therefore assumed that each is a distinct inheritance, and that the alternative to each is an absence of that fragrance. In both groups of F_1 hybrids, Recurvus scent is strongly dominant, and Tristis scent strongly recessive.

Let us first consider each type of fragrance independently. If Recurvus scent were dependent on a single dominant factor, then three-quarters of the F_2 should be Recurvus scented, either alone or in combination with Tristis Scent. The remaining one-quarter should then be Tristis scented or non-fragrant. By similar reasoning, one-quarter should be Tristis scented, alone or in combination with Recurvus, if Tristis scent were the result of a single recessive factor. Neither of these two types of fragrance even approaches these expectations. Each falls far short. This being so, either a more complex inheritance or the presence of modifying factors must be assumed.

A Two-Factor Explanation

Possibly two factors are needed to bring out each scent. If this be assumed for Recurvus scent, and we designate the two factors as *R* and *S*, and their allelomorphic non-fragrant factors as *r* and *s*, then *G. recurvus*, being homozygous for the factors for Recurvus scent, would have the formula *RRSS;* and *G. tristis*, being assumed to be homozygous for the absence of both *R* and *S*, would have the formula *rrss*. Then the F_1 hybrid would carry the formula *RrSs*. Since the F_1 has a dominant Recurvus scent, then *R* and *S*, both heterozygous, are assumed to be enough to produce Recurvus scent. In the F_2 generation there would be sixteen possible permutations of *R* and *r*, *S* and *s*. Of these, *RRSS, RRSs, RRsS, RrSS, RrSs, RrsS, rRSS, rRSs* and *rRsS;* that is, 9 contain at least *R* and *S*, and 9/16 or 56¼% should carry Recurvus



FLOWERS OF THE TWO PARENT SPECIES

Figure 1

Gladiolus tristis concolor (*A*) has a fragrance of night jasmine, which is recessive in hybrids with *G. recurvus* (*B*). The violet day-scent of the latter species is dominant in inheritance and is transmitted to all the hybrids. These species are diploids, while the garden gladiolus is a tetraploid, and produces only sterile non-fragrant hybrids with *tristis* and did not cross with *recurvus*. However, in the cross between the garden varieties and the *tristis* × *recurvus* hybrids, some seedlings are found which are fragrant and have flowers of fair size and of striking color. One-half natural size.

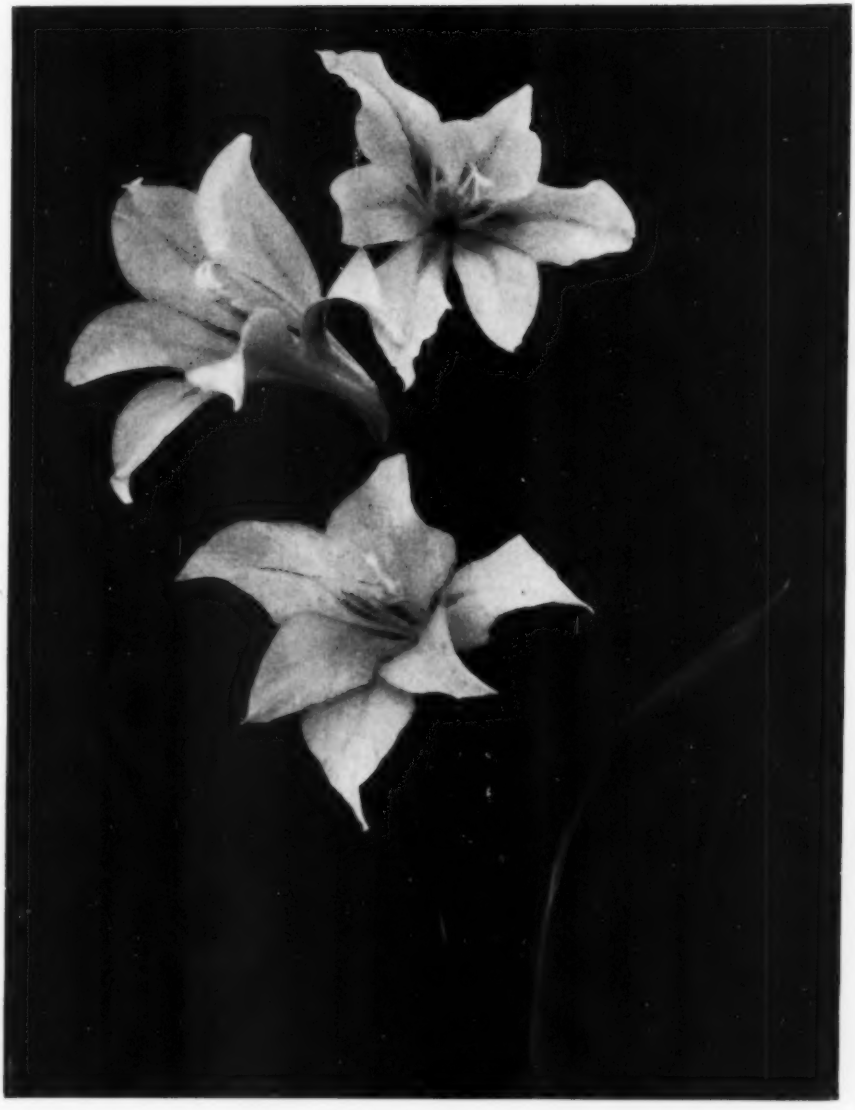
scent. Actually, combining Recurvus scented F_2 (Table I, line 2) with Recurvus and Tristis scented F_2 (Line 3) the total Recurvus scented are 196 of an F_2 total of 362, or 54.1%. Thus the deviation from the expected value is slightly over 2%, which is regarded as sufficiently close. In the backcross, since *RrSs* (F_1) is crossed with *rrss* (Tristis II), only 4/16 or 25% would have both *R* and *S*, and therefore have Recurvus scent. Actually, combining the values in line 2 and 3, Table I, in the backcross, 70 of 284 total, or 24.7%, are Recurvus scented, which is only 0.3% deviation from the expected 25%!

To get an equally close approximation for the inheritance of Tristis scent, we again assume two necessary factors, which we may designate *T* and *U*, and assume that a minimum of heterozygous *T* and homozygous *U* are necessary for Tristis scent in the absence of Recurvus scent. But in the presence of Recurvus scent also, then homozygous *T* as well as homozygous *U* are needed, with heterozygous or homozygous *R* and *S*, to bring out both scents together. Thus Recurvus scent is regarded as epistatic to a minimum dosage for Tristis scent. On this hypothesis, there are now eight factors to consider; *R*,*r*,*S*,*s*,*T*,*t*,*U*, and *u*. The possible groupings of these in the F_2 are now 256. Of these, plants having both Tristis and Recurvus scents will then have one of the following genetic formulae in the following proportions: 1 *RRSSTTUU*, 2 *RRSsTTUU*, 3 *RrSSTTUU*, 4 *RrSsTTUU*, and will constitute 9/256 or 3½% of the total in the F_2; this expected value comparing favorably with the actual 2.2% found. In the backcross 1/16 or 6¼% would be expected, and there were actually 6%.

THE HYBRIDS NOT UNIFORM

Figure 2

The Tristis × Recurvus F_1 hybrids varied in form, color and markings, but not in fragrance. All three of these had the violet scent of *G. recurvus*. Photographs natural size.



A DOUBLY FRAGRANT HYBRID

Figure 3

A backcross of the F_1 to *G. tristis concolor*. This particular plant carried both types of fragrance, violet by day and night-jasmine at night. Natural size.

Individuals having formulas containing *TTUU* or *TtUU*, without *R* and *S* both being present also, will have only Tristis scent; and will be expected to appear in 21/256 of F_2, or 8¼%, and in the backcross 6/16 or 37½%. These expected values are considerably higher than the actual one for Tristis scented alone (Lines 4 and 5). But if we lump together all of the fragrant groups not containing Recurvus scent (that is, all of lines 4 to 8 inclusive), we then closely approach the expected values for Tristis scent alone. The actual values (given as total % under F_2 and backcross in Table I) are 8.6% compared to an expected 8¼% in the F_2, and 36.2% compared to an expected 37½% in the backcross. We are accordingly led to conclude that all of these; Lemon, Pungent, and Tristis scented and combinations among them, all have the basic genetic formula for Tristis scent, *TTUU* or *TtUU*, with possibly other factors as modifiers.

The close agreement of the actual proportions of the inheritance of the different types of fragrance with the expected values based on this assumed hypothesis, is reasonable evidence in support of it. This is further corroborated by the few instances of crosses between F_1 and garden gladiolus sorts, and by later generations of the fragrant race, in all of which the proportions of fragrances found agreed very well with expectations.

The next practical question is: do the traits of the species, *G. tristis* and *G. recurvus*, link strongly enough to the factors for scent to make any of these characters practically unavoidable in the fragrant garden hybrids? Only one species trait seems to be closely enough linked to fragrance to be a real probability. *G. recurvus* has a grayish leaf color, and Recurvus scent appears to be linked to this 81.4%. None of the other characters that differ in the two species show any high degree of linkage to either type of fragrance. In fact, many of the traits of the Tristis-recurvus hybrids appear to be easily lost in crosses with garden varieties. Thus the nondescript greenish cream colors of these hybrids are replaced by shades of pink and rose in crosses with rose colored garden varieties; by lavender-violet in crosses with colored varieties, and so forth. It thus seems probable that all colors and many of the types found in the garden gladiolus may be obtained in fragrant hybrids.

Hybrids With Gladiolus Sterile

But there is one real drawback. The hybrids between the small fragrant type of sweetglad and the garden varieties are thus far consistently sterile. One reason for this may be in their chromosome numbers. They are all triploid. The little fragrant species are all diploid, with a *2n* number of 30, according to Bamford.[1] The large flowered forms, according to the same authority, are tetraploid with 60 chromosomes in each body cell. Accordingly, the hybrids combining these two groups have 45 chromosomes, 15 from the fragrant parent and 30 from the large garden variety. Yet even when outnumbered two to one by chromosomes carrying factors for non-fragrance, the two chromosomes of the fifteen, carrying the factors *R* and *S* for Recurvus scent, impart their fragrance to the hybrids. The Tristis night scent, requiring one of its two supplementary factors *T* and *U*, to be homozygous in order to bring out fragrance, of course is not transmitted to these mixed hybrids. It would require two chromosomes carrying *U*, in addition to one or two carrying *T* to transmit Tristis fragrance, and from a diploid parent only one of each of these chromosomes would normally be bequeathed to a hybrid with a non-fragrant variety.

But there are possibilities even here. Since the large flowered gladiolus varieties are tetraploid, then tetraploids may be possible in the small fragrant group, too. Perhaps following the technique of Blakeslee and Avery,[3] using colchicine, a tetraploid race of the small fragrant gladiolus may be attained. If this were homozygous for the factors for Tristis scent, then the tetraploid would have in its body cells not two genes each for *T* and *U* on four chromosomes, but four

chromosomes carrying *T* and four carrying *U*. When crossed with a large-flowered tetraploid gladiolus, this fragrant tetraploid would transmit two chromosomes carrying *T* and two carrying *U* to the hybrids. Would these tetraploid hybrids, each having two chromosomes each for *T* and for *U*, then carry the Tristis scent or not? It is interesting to speculate.

Meanwhile the dominance of the factors *R* and *S* for Recurvus scent make it easy to transmit this scent to triploid hybrids with the garden varieties, and the absence of any close linkage of the primitive species traits to the pairs of factors for Recurvus scent, except in the case of gray leaf color, makes it also relatively easy to duplicate in fragrant hybrids any of the color or form characters of the garden gladiolus. True, the triploids are, as might be expected, smaller and more slender than the sturdy garden giants. They thus partake more of the traits of the primulinus race than of the large exhibition type, but without the hooded flower or wide spacing of the primulinus. Not everyone wants giant gladioli, so this daintier type will have a following.

The little fragrant diploid race developed in this study, when crossed with the garden varieties, acts as a cameleon in heredity, taking on more of the characters of the tetraploid large parent than of its own wild ancestors, except in the trait for fragrance, which carries over readily enough. May this mean future fragrant gladioli made to order? It may be even so.

Conclusions

1. From a study of hybrids between one clon of *G. tristis* and two of *G. recurvus*, in the F_1, F_2, and a backcross of $F_1 \times$ *tristis*, the violet-like fragrance of *G. recurvus* was found to be dominant, and the jasmine-like night fragrance of *G. tristis* was recessive.

2. The Recurvus fragrance is dependent on two factors, either or both of which may be heterozygous.

3. The Tristis fragrance is also dependent on two factors, one of which must be homozygous, while the other may be heterozygous, providing the Recurvus fragrance is not also present. In the latter case it suppresses the minimum dosage of Tristis fragrance, but not a completely homozygous Tristis fragrance.

Literature Cited

1. Bamford, Roland. The chromosome number in Gladiolus. *Jour. Agr. Res.* 51:945-950. 1935.

2. Blakeslee, Albert F. Demonstration of differences between people in the sense of smell. *Scientific Monthly* 41:72-84. 1935.

3. Blakeslee, A. F. and A. G. Avery. Methods of inducing chromosome doubling in plants by treatment with colchicine. *Science* 86:408. 1937. *Journal of Heredity* 28: —— 1937.

4. Herbert, Wm. Instructions for the treatment of Amaryllis longifolia as a hardy aquatic, with some observations on the production of hybrid plants, etc. *Trans. Hort. Soc. London* 3:73-80. 1820.

5. McLean, F. T. The value of Gladiolus species for hybridizing. *Glad. Rev.* 2:7-9, No. 5, May, 1925.

6. ——————. Inheritance and chromosome number in the Gladiolus. *Torreya* 31: 65-70. 1931.

7. ——————. The inheritance of fragrance in Gladiolus species crosses. *Jour. N. Y. Bot. Gar.* 34:73-80. 1933.

8. ——————. A genetic analysis of the inheritance of fragrance of Gladiolus. *Bull. Torrey Bot Club* 65:181-197. 1938.

TABLE I. Observed and expected inheritance of Recurvus and Tristis Fragrance, based on two factors for each.

Classification of Fragrance	First Generation F_2 @@0 Tristis II x Recurvus,N.P.			First Generation F_2 @@0 Tristis II x Recurvus Bronze			Second Generation F_2 @@0 F_1 @@0 x F_1 @@0			Back Cross Tristis II x F_1 @@0		
	Observed No.	Expec. %	Expec. %	Observed No.	Expec. %	Expec. %	Observed No.	Expec. %	Expec. %	Observed No.	Expec. %	Expec. %
1. Non-fragrant	4	2.0	0	7	3.7	0	121	37.8 3/8		111	39.1	37½
2. Recurvus Scent-ed	185	97.0	100	182	96.3	100	200	62.2 5/8		82	28.7	25
3. Recurvus & Tristis	0	0	0	2	1.0	0	8	2.5 3/8		17	6.0	6¼
4. Tristis scented at night	2	1.0	0	1	0.5	0	6	1.7	*	90	31.7	*
5. Tristis day & night	0	0	0	0	0	0	2	0.6	*	6	2.0	*
6. Pungent scented	0	0	0	0	0	0	15	4.0	*	0	0	*
7. Lemon scented	0	0	0	0	0	0	2	0.6	*	2	0.7	*
8. Lemon & Tristis	0	0	0	0	0	0	3	0.8	*	3	1.0	*
Totals	191			192			360	99.6	100	299	98.2	100

* These totals are of items 4 to 8 inclusive: Tristis, Pungent, Lemon and Lemon & Tristis

EVOLUTION AND GENETICS

A SYMPOSIUM on evolution and genetics was held in Germany in 1929. In it both paleontologists and geneticists took part but failed to develop any ground for unification or reconciliation of their divergent views. This, the author states, had led him to attempt in the present volume* the task in which the participants in that symposium failed. He finds that there exists scepticism as to the reality of organic evolution both among geneticists and among paleontologists. Thus H. Nillson (1935) expresses the view that "the theory of evolution has not been verified by experimental investigation of the origin of species." And Daqué and other paleontologists hold that the various types (phyla) of animals and plants give no evidence of having been derived one from another, but through all geological time have remained distinct. Within a particular type of organization (echinoderm, arthropod, vertebrate, for example) there has been progressive modification, but the limits of each type have not been transgressed.

The author concedes that we do not find in the geological record types intermediate between the phyla and holds that we should not expect to find them, for the reason that fully developed (mature) types of organization have not arisen one from another, but trace back to a common ancestral condition in the early stages of their ontogeny, one from which they have deviated in various ways in their further evolution, an imperfect record of which is often recapitulated in ontogeny.

He cites specific examples from the geological record to show progressive modification in a particular direction having its beginnings in early ontogenetic stages and attaining a more advanced condition in the mature forms of later geological ages.

Such are, among the foraminifera the development of an inrolled from a straight ancestral type, and the development of many-celled from one-celled ancestors; among cephalopods, the development of coiled from uncoiled ancestral types. Among primates, we find close resemblance in skull form between man and the higher apes, only in early ontogenetic stages, subsequent to which the lines of development progressively diverge, so that it would be ridiculous to state that one mature form was derived from another. Both have descended by divergent paths from a common ancestor, simpler and more primitive than either in its mature state.

In an attempt to combine and synthesize the findings of paleontology and of genetics Schindewolf concludes that the *phylogenetic origin of new types takes place through gene mutations operating on early ontogenetic stages.* Such mutations are random in occurrence and have no directly adaptive character. Natural selection alone determines their persistence. Lamarckism accordingly is rejected. Darwinism is found an inadequate explanation of evolution unless it is supplemented by and based upon the theory of gene mutation, not excluding possible plasmatic inheritance.

Speaking as a paleontologist, he finds that in phylogenetic evolution two distinct phases can be recognized (1) a usually brief phase of the discontinuous and explosive origin of new types and (2) a subsequent phase of longer duration in which the types change progressively and more slowly through the origin and selective elimination or retention of minor modifying gene mutations. This last phase corresponds more nearly with the Darwinian aspect of evolution, the preceding one is purely mutational.

W. E. CASTLE

University of California

*SCHINDEWOLF, OTTO H., Paläontologie, Entwicklungslehre und Genetik. 108 pp., 34 figs. Borntraeger, Berlin, 1936.

SPONTANEOUS TAIL AMPUTATION IN THE NORWAY RAT*

G. W. Wooley and L. J. Cole
Roscoe B. Jackson Memorial Laboratory, Bar Harbor, Maine
Department of Genetics, University of Wisconsin, Madison, Wisconsin

HEREDITY OR ENVIRONMENT?

Figure 4

Mature rat with greatly shortened tail due to spontaneous amputation. Such rats have appeared in a number of laboratories. The condition has been variously attributed to nutrition, to heredity, and to parasites. It is probably the result of a particular combination of hereditary and environmental conditions.

ALTHOUGH inherited tail defects have been reported for a number of mammals, none appears to have been reported for the rat. Conrow,[2,3] King,[4] and Hutt[5] have studied taillessness in the rat and all concluded that the cases under observation were not hereditary but due to somatic variation or to some inhibition of development in early embryology.

In 1932 the authors mated and started inbreeding albino rats (*Rattus norvegicus*) having greatly shortened tails (approximately 2-4 cm. mature length) that had appeared in the genetics colony. In 1934 two hooded rats with similar

*Paper from the Department of Genetics, Agricultural Experiment Station, University of Wisconsin, No. 224. Published with the approval of the Director of the Station.

shortened tails (2 cm. mature length. Figure 4) were added to the colony through the kindness of Professor I. L. Hathaway, University of Nebraska, where rats with shortened tails were appearing in the nutritional laboratory colony. The defect has proven identical in the two strains thus started. Through correspondence with other laboratories it has been learned that the defect may be rather widespread.

The tail amputation, which is the cause of the shortened tail, and which is spontaneous, usually takes place between the 10th and 20th day after birth. If the tail is not amputated at this time the defect is rapidly outgrown. At birth the entire rat appears normal. About the 10th day the tail becomes furrowed with a varying number of grooves, the intensity of the latter depending upon the mating in question and certain other factors to be discussed later. By the 14th day the condition becomes pronounced, as is illustrated in Figure 5 *A* and *C*, which are of litter mates. The tails do not appear swollen or inflamed, as might be expected if an infection had occurred. A few days later (Figure 5 *B*, *D* shows the same rats at 21 days of age) a dry necrosis sets in, the end of the tail shrivels, and the distal part, beyond the more intense grooving, soon drops off. Neither the grooves nor the points of subsequent severing are between the caudal vertebrae, as might be expected, but are at the mid-region of individual vertebrae. The offspring from various, and even individual, matings differ in the location of intense grooves (Figure 6 shows variation in a single litter), some having them near the tip and others about two-thirds of the way towards the body. The greatest variation in incidence of the defect under Wisconsin laboratory conditions has been a seasonal one. The fall and winter season are favorable and the spring and summer unfavorable for the appearance of the intense grooves causing amputation. In summer, a classification of the young is not possible.

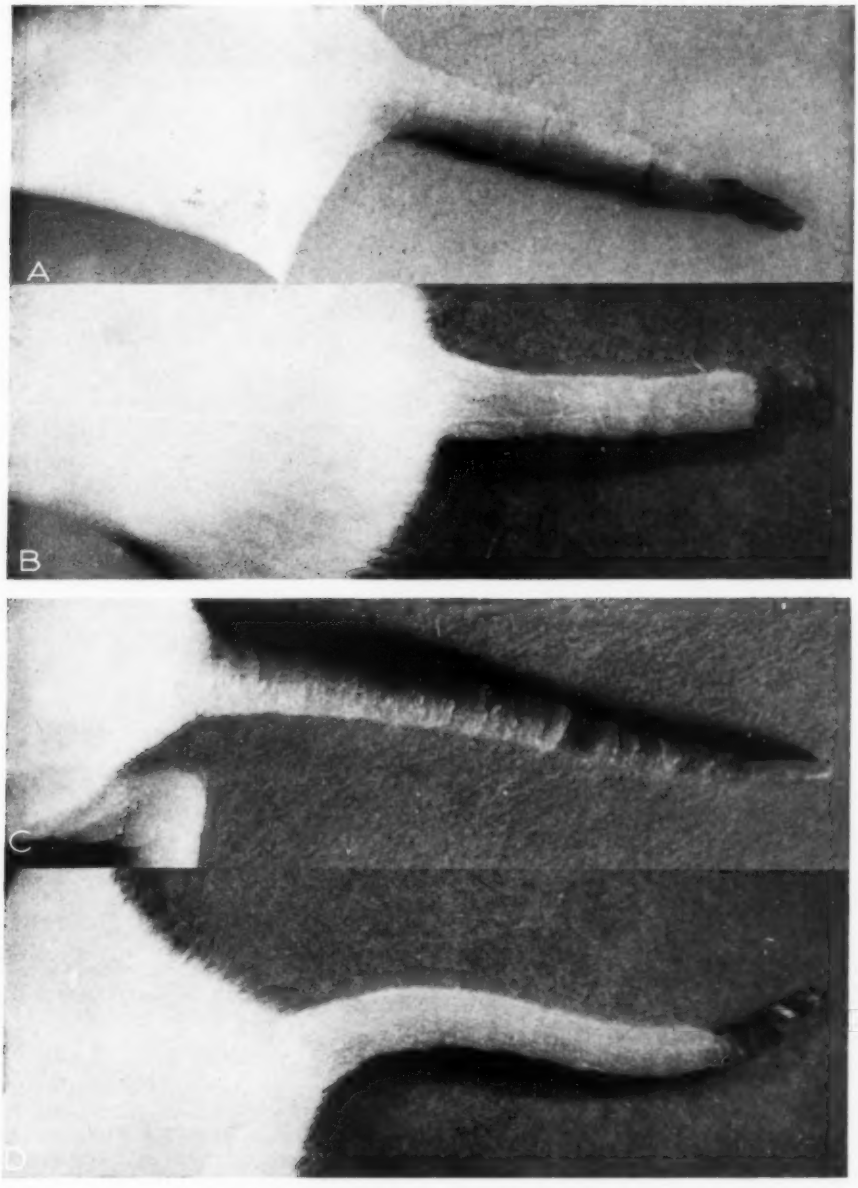
Other characteristics peculiar to these strains have been observed. The legs and feet, especially the posterior ones, become scaled and pitted; many times toes are amputated and in two instances a hind foot has been autonomously amputated. Scales usually appear on the dorsal parts of the body. Scaling of body, amputation of toes and tail amputation are correlated with season and it seems that in all cases it is the skin and extremities that are affected. The appearance of all of these characteristics suggests that there is a general disturbance of the peripheral circulation in the defective animals.

The possibility that the amputation originates from faulty nutrition, or sanitation, rather than from hereditary causes has been considered in this and in other laboratories. The experience of the nutrition laboratory at the University of North Dakota as related by Professor F. W. Christensen is as follows:

> . . . at one time I thought this might be hereditary, but later on I read the article by Burr and Burr* showing a similar condition in rats on diets that were deficient in linolenic acid, consequently I increased the linolenic acid by feeding more corn oil and for a time I was getting results. During the past year we have had a large number of rats losing their tails, usually between birth and weaning time, that is, about four weeks old. . . . Rats affected with this condition usually show a flaky condition of the skin and the tails gradually shrivel and finally break off.

At the University of Illinois the trouble was combatted by careful sanitary methods such as using cages with raised bottoms and frequent washing of the cages, together with treatment of the tail of the young rats with a grease composed of parawax, vaseline and creoline. Later when the rats were changed to a feed mixture which seemed to nourish then somewhat better than previously they seldom developed the tail defect. It is possible that the modification of the ration may have been made at a season when the defect is normally not pro-

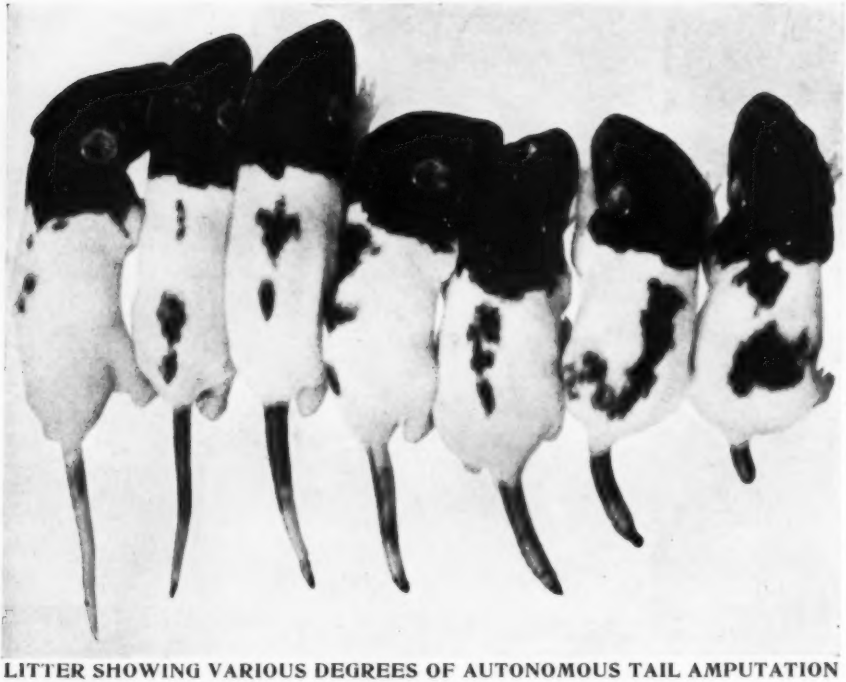
*Evidently *J. Biol. Chem.* 82:345 (1929); *ibid.* 86:587 (1930). Not produced in the unweaned rat.



SPONTANEOUS TAIL AMPUTATION

Figure 5

Grooved tail of two littermates at 14 days of age (*A, C*), and 21 days (*B, D*). By the end of the third week of life, the tails had become spontaneously amputated at the region of the deepest groove.



LITTER SHOWING VARIOUS DEGREES OF AUTONOMOUS TAIL AMPUTATION

Figure 6

This defect is probably due to some genetic "susceptibility" factor in connection with certain intangible elements in the environment. Incidence of the defect is greatest in fall and winter. That expression of the character is determined in part by prenatal intra-uterine conditions is indicated by the range of variability within litters.

nounced. This same sanitation and vaseline treatment was tried at the University of North Dakota and was not effective as a preventive measure.

The strain under discussion at the University of Illinois had its origin at the Wistar Institute. Correspondence with F. L. Duhring reveals that such defects have been experienced in the past in the Wistar colony and that they have corrected it almost entirely through diet.

Findings at the University of Nebraska are in accord with a hereditary interpretation. In 1930 rats were secured from three widely separated laboratories and in 1935, at which time the defective stock was culled out, it was found that all defective litters traced to only one of the three strains. However, attempts to reproduce the defect by various brother to sister, son to dam, and sire to daughter matings met with but little success. Rough tails, but none of the extremely short ones, were produced.

At the University of Wisconsin defective producing and non-defective producing strains* have been raised and littered side by side, and always on the same stock diet, without any appearance of defective animals in non-defective strains. At times, under presumably

*A non-defective strain was kindly furnished in 1934 by Dr. H. W. Feldman. No unusual tail conditions were noted in this 18-generation inbred strain by Dr. Feldman at the Univ. of Michigan, nor subsequently at the Univ. of Wisconsin.

favorable conditions, the defect appears in one form or another in 100 per cent of the offspring in the inbred defective lines. In a few crosses between two such defective strains the abnormality appeared in the F_1. After crossing defective and non-defective strains, the abnormality again appeared in the F_2 generation, but because of intermediate expression, classes were not established in the latter instances. No differences due to the sex of the parent or of the offspring were observed.

Further study of this abnormality may give an answer to a number of points of interest. A strong seasonal effect has been noted, defective tails appearing in the winter months even though the room temperature was well above 70°F. Length of day was perhaps a factor as this was uncontrolled. One wonders how the seasonal effect is possible in animals only 14 to 21 days of age. Is it expressed through the parents, or do the young perhaps have more sluggish circulation as a direct response to the environment? An analysis of the genetic factors involved must await a more complete understanding of, and ability to control, the factors which would keep the expression of the defect more pronounced. A detailed anatomical picture of the amputation would also be of much interest. Gross observation revealed transverse blood vessels with varying degrees of engorgment just prior to groove formatiton.

The defect here described represents a type of developmental abnormality which is probably much more common than is ordinarily supposed. As has recently been emphasized by one of us[1], such characters are likely to be considered as "non-hereditary" when the hereditary influence is not apparent. With normal heredity, the normal character is commonly produced under a wide range of environmental conditions; this is doubtless a biological "factor of safety" which aids in the preservation of the individual and of the species. A change in the heredity (mutation of one or more genes) may change the developmental threshold value so that the individuals of this composition are predisposed to abnormality — particularly arrest of development — under certain conditions. The opportunity for such arrests in mammals is naturally greatest during intra-uterine life when the early developmental processes are taking place; and when such conditions are near the threshold value for the expression of a "defective" gene, great variability may result in the incidence and degree of the character. In the case of the litter shown in Figure 6, it is impossible to say with certainty whether the variation in tail amputation is due to segregation of genetic factors, to variability in the intra-uterine conditions to which the individual fetuses were exposed, or to a combination of the two sets of conditions. On the basis of the breeding, however, it seems quite probable that the heredity is the same in the whole litter and that the variation shown is "non-hereditary."

Summary

An abnormality causing frequent spontaneous tail amputation in the rat has been found to be confined to specific strains and to be transmitted as a hereditary difference, probably recessive, between these strains. A seasonal variation in expression was noted.

Literature Cited

1. Cole, Leon J. The importance of threshold characters in animal breeding. *Amer. Soc. Anim. Prod. Proceedings for* 1937. Pp. 291-296. 1938.
2. Conrow, S. B. Taillessness in the rat. *Anatomical Record* 9(10):777-784. 1915.
3. ————. Further observations on taillessness in the rat. *Anatomical Record* 12: 155-159. 1917.
4. King, H. D. Structural anomalies in the rat. *Amer. Jour. Anat.* 48:231-260. 1931.
5. Hutt, F. B. Congenital taillessness in the rat. *J. Hered.* 23(9):363-367. 1932.

◆

U. S. Population Growth

THE Bureau of the Census estimates the population of the continental United States to be 128,877,000 on January first, 1937. This represents an increase of 6,101,954 since the last Census, April 1, 1930—an average increase of

nearly a million a year. These figures are based on estimates and interpolations from previous figures, vital statistics, etc. They are given separately by states. Four states show no gain in population according to these estimates: Rhode Island, South Dakota, Nebraska and New Mexico. New York—the largest state—has a population of 12,948,000, more than all the West South Central Group of states combined (Arkansas + Louisiana + Oklahoma + Texas = 12,850,000). Pennsylvania, the second largest state (10,158,000), showed a greater gain in population (53,000) than New York (33,000).

While population increases are large numerically, the percentage rate of gain of less than one per cent a year is much less than earlier in United States history, when gains as high as 3.5 per cent a year were maintained for long periods. It should be noted that the present growth is entirely biological rather than transportational because since 1930 emigration has nearly equalled and in some years exceeded immigration for the first time in U. S. history.

The fact that the *rate* of population growth is rapidly falling is emphasized by an earlier Census Bureau statement that more than a million less children entered school in 1937 than in 1930. The age distribution of our population is now such that the next decade will almost certainly show very great changes. There is no doubt that the "average American" is older today than in any time since he became a statistical entity.—R. C.

✦

TEACHER = KIBITZER? — AND WHAT IS TRUMP?

IN an article by Dr. Paul Popenoe in the February number of the JOURNAL, there occurred a paragraph in which he compared the sorting of the genes for intelligence to the shuffling of a deck of cards. This comparison stimulated thought as to further comparisons beyond that represented by the article.

If, as one may infer from the article under consideration, one player were to hold all clubs and if clubs were trump, then he certainly would have an advantage over every other player who held a smaller number of clubs,* assuming that all clubs were of equal value. More than that, one's ability to win would be positively correlated to the number of trump cards held. And if it were conceivable that one held *no* trumps, he certainly could not succeed in winning a single trick. The comparison seems to be a very fair statement of the situation as we now understand the random sorting of genes.

With this conception in mind, certain important questions arise. First, could someone standing behind a player so instruct him that with a rather poor hand he could take the trick from one who held a better hand but who did not know how to play his cards? That is, can a teacher (education, training) so contribute to the lesser endowed that he can win more tricks than he otherwise would? And is that *the* function and the *only* function of education,—to teach one how to play his hand?

Secondly, just what is trump today? The ability to make money? To earn a livlihood? In college it seems to be to make all *A*'s, and will this be the trump card in after life? And if it is or is not, may we hope for a time to come that what is trump in college will also be trump in life?

And lastly, what about those poor souls who hold no trump at all? Will the trump-holders always have to look after their welfare? for the prospect of breeding a race of trump-holders is still an iridescent dream whose fulfillment is far in the future.

EDWIN E. JACOBS
Ashland College, Ashland, Ohio

*Biologically possible, though Hoyle and Culbertson might not concur.—ED.

DENTAL ABNORMALITIES IN CLEIDO-CRANIAL DYSOSTOSIS

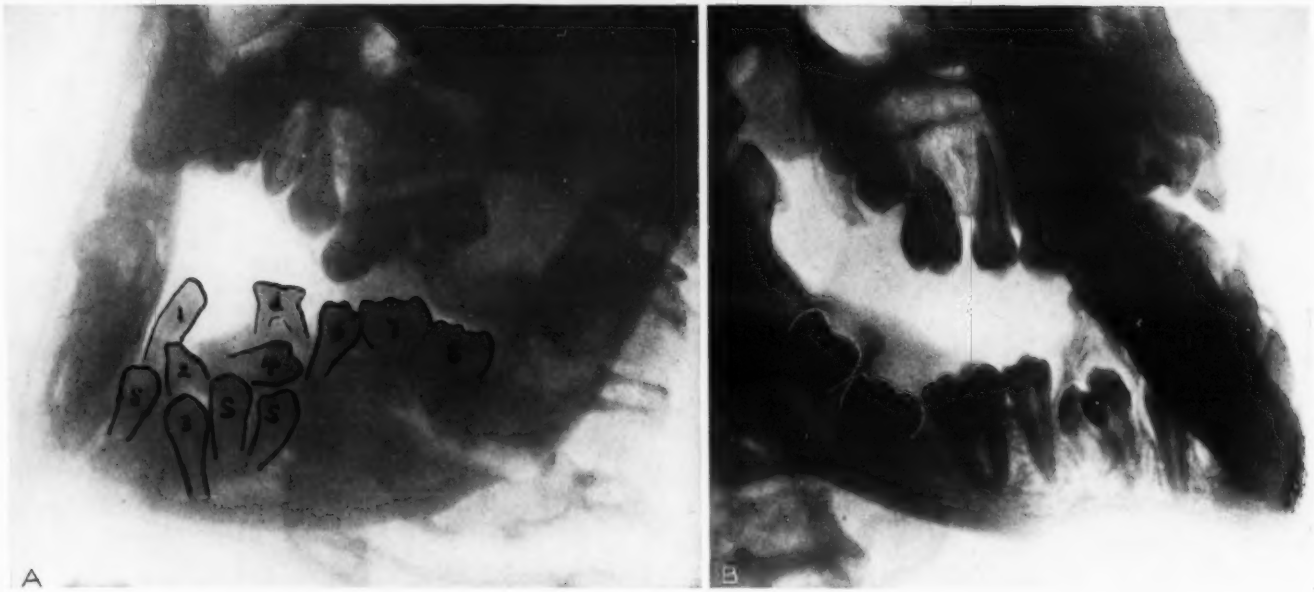
MARTIN A. RUSHTON
From the Dental Research Laboratory, Guy's Hospital, London

DIAGNOSTIC CHARACTERISTICS

Figure 7

A—Full face view of *L.D.* showing the great width of cranium, widely separated eyes, sunken bridge of nose, and small upper jaw bone (maxilla). *B*—Profile portrait of *E.D.* showing prominence of forehead, and sunken bridge of nose. The syndrome of skeletal defects which characterize this inherited disability indicate a profound disarrangement of the bone-forming mechanism.

WHILE the bone defects and manner of inheritance of cleido-cranial dysostosis have received considerable attention, it is only recently that a few detailed accounts of the dental abnormalities accompanying the condition have been published. It is well known that many teeth fail to erupt or do so late in life, and Stocks[5] made the suggestion that the dental defects arose from restriction of the erupting area by stunting of the jaws. Payne[3] expressed the opinion that failure of eruption was due to a defect of calcium metabolism, and noticed that in some cases teeth did not erupt although the jaws were not stunted in growth. He published the pedigree of a large family in which the dysostosis occurred and drew attention to the presence of supernumerary teeth in five affected members. He considered that the two conditions were unrelated. Frölich[1] recorded an East Prussian Jewish family in which the dysostosis was hereditary and in which two of the affected members had supernumerary teeth: one of these had also insufficient molar teeth and many dentigerous cysts. He assumed that these dental abnormal-



DENTAL DISARRAY IN THE LOWER JAW

Figure 8

A—Radiograph of right side of mandible of *L.D.* showing failure to erupt of teeth 8-4-3-2. In addition to the normal teeth, three supernumerary teeth (*S*) are also present in the jaw, but have not erupted; *d* is a milk tooth. *B*—Radiograph of the left side of the mandible of *C.W.* showing six normal teeth unerupted (3-4-5-6-7-8) and also a supernumerary premolar.

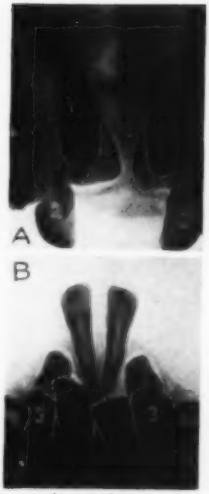
EXTRA INCISORS

Figure 9

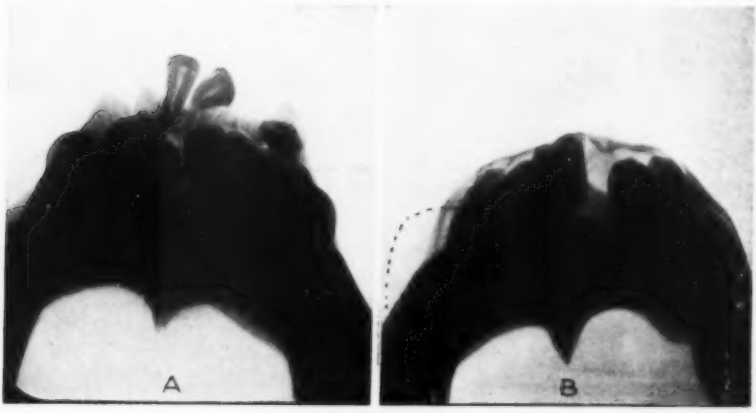
Radiograph of maxilla (upper jaw) of *V.W.* to show appearance of slight compression of crown of one of the supernumerary central incisors (*S*). The normal teeth are numbered 1, 2, 3, etc., from the mid-line. 1 and 3 are not erupted. *C* is a retained milk-tooth.

EXTRA AND BURIED INCISORS

Figure 10



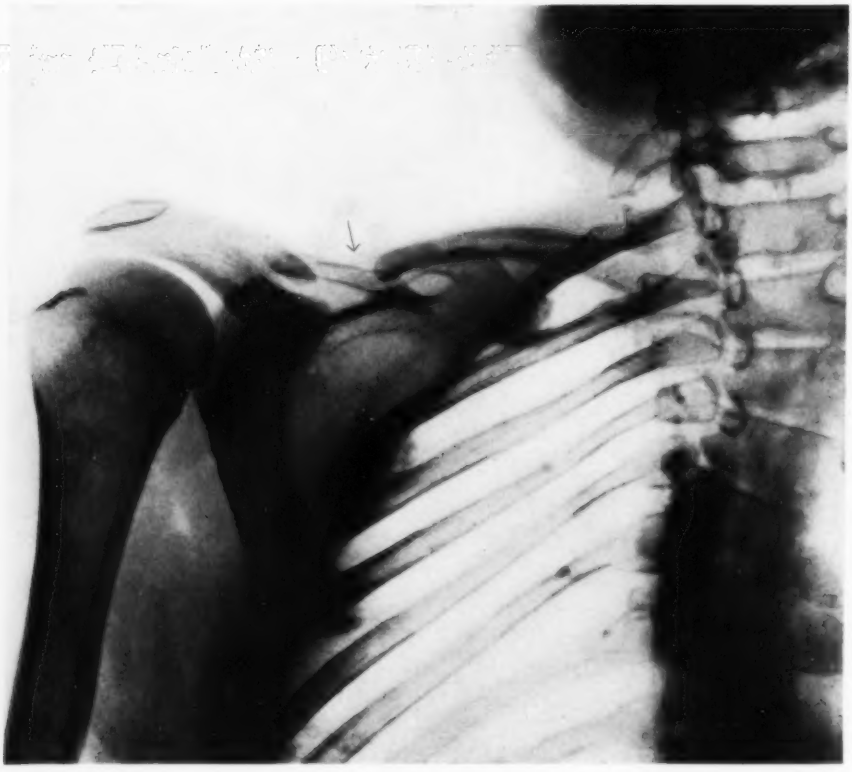
Upper and lower jaws of *D.B.*, showing unerupted incisors. *A*—In the premaxilla four incisors are unerupted, two of which are supernumerary. One tooth is conical and another shows rounding of the incisive angles: 2, 2 are the erupted lateral incisors. *B*—In the incisor region of the mandible only the central incisors are erupted and there are two supernumerary teeth. The crowns of the unerupted teeth nearest the surface appear deformed. 3, 4—Unerupted cuspids and bicuspids.



RETARDED BONE FUSION

Figure 11

A—Mental region of lower jaw of *L.D.* showing incomplete junction at the symphysis, spine-like genial projection, and many unerupted and supernumerary teeth. *B*—The same for *E.D.*, showing in addition to the above features several cysts, the outline of the largest being dotted. The cysts probably originated through the degeneration of epithelial remnants around the crowns of unerupted teeth.



VESTIGIAL COLLARBONES

Figure 12

The classic defect of cleido-cranial dysostosis is that on account of the failure of the collarbones to ossify, the shoulders can be brought forward, so that they almost touch. The deficient collarbone is here indicated by an arrow.

ities, as well as failure of eruption, should be considered a part of the syndrome. The writer[4] published four cases from three unrelated families: in all these supernumerary teeth were found and in one also dentigerous cysts, confirming Fröhlich's opinion. The object of the present paper is to summarize and discuss the knowledge at present available and to add several details which appear important.

Classification of Tooth Defects

The dental abnormalities may be considered under five headings: (1) supernumerary teeth, (2) failure of eruption, (3) deformities of the teeth, (4) abnormalities of the jaw, and (5) dentigerous cysts.

(1) *Supernumerary teeth.* These, when present, are found in the incisor or premolar regions of one or both jaws: in only one case was a supernumerary tooth found in the (upper) molar region. The disposition is sometimes symmetrical; and the number may vary from 2 to 14 (though in the latter case some molar teeth of the normal series were missing). The supernumerary teeth usually bear a considerable resemblance to normal tooth forms but are occasionally conical (Figures 9

SKULL DEFECTS

Figure 13

Radiograph of skull of *E.D.*, showing open anterior fontanelle (below askrisk), which should close at two years of age, and failure of sutures to close (zig-zag lines).

and 10). None has been found in connection with the deciduous dentition, the only abnormality here being developmental incomplete fusion of the left upper central and lateral incisors recorded by Payne in one case.

(2) *Failure of eruption.* The deciduous teeth do not remain unerupted, and of the permanent dentition those which least commonly fail to erupt are those which normally appear first, the first permanent molars and the lower central incisors. After this there seems no general rule: the upper central incisors very frequently remain buried in the jaw. The failure of eruption is not confined, as has been suggested, to teeth which have deciduous predecessors; and the first molars, though they usually erupt, may all do so several years late. Teeth often appear through the mucous membrane of the mouth late in life but this may be the result of absorption of the overlying tissue following the wearing of artificial dentures.

(3) *Deformities of the teeth.* (a) *The roots.* It is common to find the

roots of some or most of the teeth, especially of those which have not erupted, to be of very uneven appearance as if the direction of growth had changed abruptly many times. The apical ends are often sharply curved or hooked, which makes their removal difficult, and there may be some spiral twisting.

(b) *The crowns* of the erupted teeth do not appear abnormal, but those of the unerupted teeth frequently show pits and ridges due to uneven enamel deposition. In addition the whole crown sometimes seems compressed towards a more spherical or conical form, and this is particularly true of the supernumerary teeth. (Figures 9 and 10.)

(4) *Abnormalities of the jaws.* The maxillae are usually small but the mandibles do not appear so. In the lower jaw particularly there is often plenty of room for the teeth to erupt. An abnormal feature which I have observed in two of my cases, *L.D.* and *E.D.*, a brother and sister, does not seem to have been previously recorded and may be part of the syndrome. The region of the genial tubercles is prominent and prolonged into sharp points not united in the mid-line; and there is incomplete union at the symphysis menti (Figure 11.)

(5) *Dentigerous cysts* in these cases are probably secondary to failure of eruption and due to the proliferation and degeneration of the epithelial remnants about the crown of the tooth (Figure 11).

The following cases are summarized to illustrate the points mentioned:

L.D., a woman of 30, has the characteristic facies as shown in Figure 7*A*. The following teeth were erupted $\frac{84 \mid 47}{75d1 \mid 15}$ and $\frac{5321 \mid 12358}{8432 \mid 23478}$ were unerupted. In addition there were one supernumerary tooth in the premaxilla, two in the lower incisor, and two in the right lower premolar region (Figures 11*A* and 8*A*). She had partially deficient clavicles and incomplete union at the mental symphysis.

E.D., aged 36, brother of the above, had believed that he had had all his teeth extracted. He was moderately dwarfed and had an unclosed anterior fontanelle, no frontal sinuses, expanded skull, and partially deficient clavicles. There were three unerupted teeth in the upper jaw and eleven in the anterior part of the mandible, also dentigerous cysts in both jaws. Many of the unerupted mandibular teeth were supernumerary (Figures 11*B* and 7*B*).

D.B., a girl of 14, had $\frac{7543c2 \mid 23457}{1 \mid 17}$ erupted and $\frac{1 \mid 18}{875432 \mid 23458}$ unerupted.

Four supernumerary teeth were present, symmetrically in upper and lower incisor regions (Figure 10). The clavicles were partially deficient but deformity of the skull was slight. There was a negative family history in this case.

C.W., a girl of 18, had considerable deformity of the skull and partial deficiency of the clavicles. She had $\frac{74cb \mid bc457}{65c21 \mid 1cd}$ erupted and $\frac{85321 \mid 1238}{8743 \mid 2345678}$ unerupted. There were two supernumerary premolar teeth, one on each side of the mandible (Figure 8*B*).

Comment

It appears possible to ascribe the appearance and behaviour of the teeth which fail to erupt to a partial defect of the bone absorption mechanism of the jaws. Grüneberg's[2] observations on the grey-lethal mutation of mice show some analogy. Here the main feature of the skeleton was the entire lack of secondary absorption processes. No tooth ever erupted, the crowns of many teeth showed compression, and the long incisors became kinked and spirally twisted owing to the unyielding resistance of the bone. He considered that the failure of the bone to absorb in response to the pressure of the growing tooth was due to the lack of a factor which he called "the hereditary basis for response" in the stimulus-response mechanism. Many of the characteristics of the teeth in cleido-cranial dysostosis, such as hooked and distorted roots, compression of crowns, and fail-

ure to erupt suggest that a similar factor is here concerned though in a localized and milder form.

The relation of the supernumerary teeth to the bone defect is obscure. It is possible that dichotomy of the presumptive teeth may be secondary to the abnormality of the jaw processes, and that the normality in number of the deciduous teeth may indicate that the jaw processes are normal at the time these teeth are differentiated and become abnormal later. I have observed supernumerary teeth in a case of hereditary oxycephaly, where the shape of the skull may also be regarded as a centrifugal compression form, and it is possible that further study of the dentition in various inherited bone dysplasiae may throw more light on the matter.

Literature Cited

1. Fröhlich, E. *Dtsch. Zahn-, Mund-Kieferheilk.* IV, 157. 1937.
2. Grüneberg, H. *J. Anat.* LXXI, 236. 1937.
3. Payne, J. Lewin. *Trans. Brit. Soc. Orthodont.*, 17. 1929.
4. Rushton, M. A. *Guy's Hosp. Repts.* LXXXVII, 354. 1937.
5. Stocks, P. *Hereditary Disorders of Bone Development.* Cambridge. 125. 1925.

GENETICS CONGRESS PLANS

"NOTICE No. 1," regarding the Seventh International Genetics Congress has just been received from Dr. F. A. E. Crew, Secretary General. Since many readers of the JOURNAL will be interested in this matter, the notice is printed in full:

I have pleasure in informing you that the Seventh International Congress of Genetics will meet in Edinburgh in 1939. It now seems most probable that the dates originally suggested, August 23rd to 30th, will be those finally selected, for although they are inconveniently early for some plant geneticists they avoid the dates of the Seventh World's Poultry Congress, Cleveland, Ohio, July 28th-August 7th, and of the British Association Dundee meeting, August 30th-September 6th. Apart from this I learn that many who intend to come must be back at their University posts by the middle of September at the latest.

The Organizing Committee have selected as President of the Congress Dr. N. I. Vavilov, Vice-President of the Lenin Academy of Agricultural Science, Director of the Institute of Plant Industry, Leningrad, and of the Institute of Genetics of the Academy of Sciences of the U. S. S. R.

It is most likely that the Membership Fee for the Congress will be Two Guineas (£2: 2: 0), this covering participation in all the general activities of the Congress and the receipt of the printed proceedings which are to appear as a special volume of the *Journal of Genetics.*

The plenary sessions of the Congress and the meetings of the different sections will be accommodated in the rooms of the five University Departments of the King's Buildings group. The adjacent Students' Union includes dining, tea and common rooms. Accommodation for some two hundred members will be found in certain of the Students' Hostels, whilst for the rest adequate Hotel accommodation has been tentatively booked. The cost of board residence in the Students' Hostels ranges from two pounds, ten shillings, to three guineas a week, while the rates at the different Hotels necessarily vary according to their size and status.

Messrs. Pickfords, Ltd., have been appointed official travel agents for the Congress and they are to be responsible for the making of satisfactory hotel arrangements. They will be communicating with all those who signify their intention of attending the Congress.

It is proposed that during the week before the Congress opens there shall be a pre-Congress tour, the actual details of which, of course, be determined by the wishes of those who propose to join it. Receptions and Demonstrations necessarily of interest to members of the Congress will be arranged by certain of the University Departments and Research Institutions in London, Cambridge and elsewhere. It is thought that possibly a tour from London by motor-bus, which would include visits to these Departments and Institutions and at the same time pass through selected regions of typical English scenery, would appeal to many of those who are coming to Edinburgh for the Congress. This tour should end in Edinburgh on the early evening of Tuesday, August 22nd.

The programme of the Congress is at the present time tentative and somewhat vague. It can only take final shape when the Organizing Committee has been made aware of the particular interests and desires of the Members and when it is known who definitely is coming. However, in general it is thought that a programme more or less after the following pattern would prove to be agreeable to most.

On the evening of Tuesday, August 22nd, there will be an informal gathering in the

Departments out at King's Buildings where facilities for registration will have been provided and where demonstrations will have already been staged.

On the morning of the first real day of the Congress the Inaugural meeting will be held. At this there will be addresses by the President of the International Committee, the President of the Congress and also by representatives of the City and the University of Edinburgh. In the afternoon there will be a plenary session at which it is thought selected speakers might deal with certain chosen aspects of Gene and Chromosome Theory. In the evening it is intended to hold one of the Official Receptions.

On the morning of Thursday, the 24th, there will be a plenary session at which selected speakers will deal with the Genetic Aspects of Evolution. In the evening the President will be invited to give his address.

The plenary session on the morning of Friday, the 25th, will be divided into two parts, one concerning itself with Animal Breeding in the light of genetics, the other with Plant Breeding in the light of genetics and again selected speakers will take part. In the evening it is suggested that a lecture, possibly a public lecture, should be given by one of our Members.

The plenary session on Saturday morning will be devoted to Physiological Genetics (Gene expression in its biochemical, physiological and developmental aspects). In the evening it is proposed to have a Reception at the Zoological Park.

On Sunday, the 27th, the whole Congress will move out of Edinburgh by special train to the Highlands. Meals will be taken en route and the train will wait while those who wish may walk for a little amid typical highland scenery.

It has been suggested that the plenary session on the morning of Monday, the 28th, might well be devoted to a general consideration of Polyploidy and Hybridization in Plants and already a number of workers in this field have been approached with a view to their taking part. In the evening of this day the second Official Reception will be held.

On Tuesday, the 29th, the morning plenary session will be devoted to "Human Genetics," while that on the evening of Wednesday, the 30th, will concern itself with "The Properties of the Chromosome."

In addition to these plenary sessions, at which for the main part only such as have been selected and specially invited will speak, there will be sectional meetings on the afternoons of Thursday, Friday, Saturday, Monday, Tuesday, Wednesday and also on the morning of Wednesday, the 30th. The number of the sections and the topics or interests which will determine their discussions are not yet clearly known, but in a general way the idea is that several shall run concurrently and that on each occasion the subject shall be introduced by someone specially invited, this introduction taking the form of an orientational review. It may be assumed that there will be sectional meetings which will deal with the subject matters presented in the plenary sessions; for example, Animal Breeding, Plant Breeding, Physiological Genetics, Human Genetics, Gene and Chromosome Theory and so forth. But in addition it is to be hoped that there will be sectional discussions dealing with such matters as Poultry Genetics, the genetical work on Cancer, recent Virus work, Transplantation work, the Salivary Gland work and Statistical Genetics.

May I express the earnest hope that you will find it possible to come to Edinburgh for this meeting and to take part in its discussions. I shall be indeed grateful to you for any suggestion you care to make concerning either the general arrangements or the programme itself. Will you inform me at the very earliest possible opportunity of your intentions, giving me the title of the paper that you wish to submit to the Organizing Committee for consideration, advising me as to which particular section in your opinion it most appropriately belongs, the time you will require for its presentation (fifteen minutes may be regarded for the present as the maximum) and whether or not it will be illustrated by means of lantern slides. It is absolutely essential that the abstract (as succinct as possible—not exceeding five hundred words) of your paper should be in my hands by the 14th of June, 1939, at the very latest. You will understand that my task will be made much lighter if abstracts reach me long before this date. I cannot guarantee, of course, at this stage that all papers presented will be accepted for publication in the Proceedings.

One of the outstanding features of the Ithaca meeting was, I think you will agree, the excellence of the demonstrations, and I should like to give considerable prominence to these at the Edinburgh meeting. May I ask you therefore to prepare a demonstration illustrating your work, if this is possible, and to inform me as soon as you conveniently can what space and what special equipment will be needed, e.g., microscope, wall-space, framework, etc. In those countries in which a Genetical Society exists it will be most satisfactory if its members will inform its secretary of their wishes and intentions.

I shall be delighted to give you further information, if and when such exists, concerning any point that I have not now made clear. May I ask you to bring the Congress to the notice of all geneticists known to you.

In order that I may form some idea as to the numbers of those who hope to attend the Congress and also that I may begin seriously to think of the construction of the programmes for the sectional meetings, may I ask all who expect to attend to inform me, just as soon as possible on the following points:

(*Concluded on page* 148)

HEREDITARY ACHOLURIC JAUNDICE

in a New Mutant Strain of Rats

C. H. GUNN*

Department of Biology and Connaught Laboratories, University of Toronto, Canada

A NEW mutant strain of rats was discovered in 1934 among the breeding stock of the Connaught Laboratory animals. The mutant appears relatively yellow in color owing to an abnormal amount of bile pigment in its system; or in other words it is jaundiced.

In animals other than man there appears to be no record of hereditary jaundice, save that of the rat, in which the icterus (yellow pigmentation) is evident at birth or shortly afterwards and persists throughout the life of the animals. The first indication of a new mutation relates to the observation of three young of a litter of thirteen which had a definite yellow tinge, while both parents were normal in appearance. The original rat stock is of Wistar origin, among which Dr. Helen Dean King has no record of such a mutation.[5]

Human Jaundice

In man, acholuric jaundice was first accurately described by Minkowski[6] at the beginning of this century. Little was understood of the disease however, until Chauffard[2,3] made the important observation that the red blood cells showed a markedly diminished resistance to hypotonic salt solution and also observed that reticulocytes were usually present in large numbers. Widal[8] was the first to recognize the fundamental haemolytic nature of acholuric jaundice, i. e., that it was caused by an agency which destroyed large numbers of red blood cells.

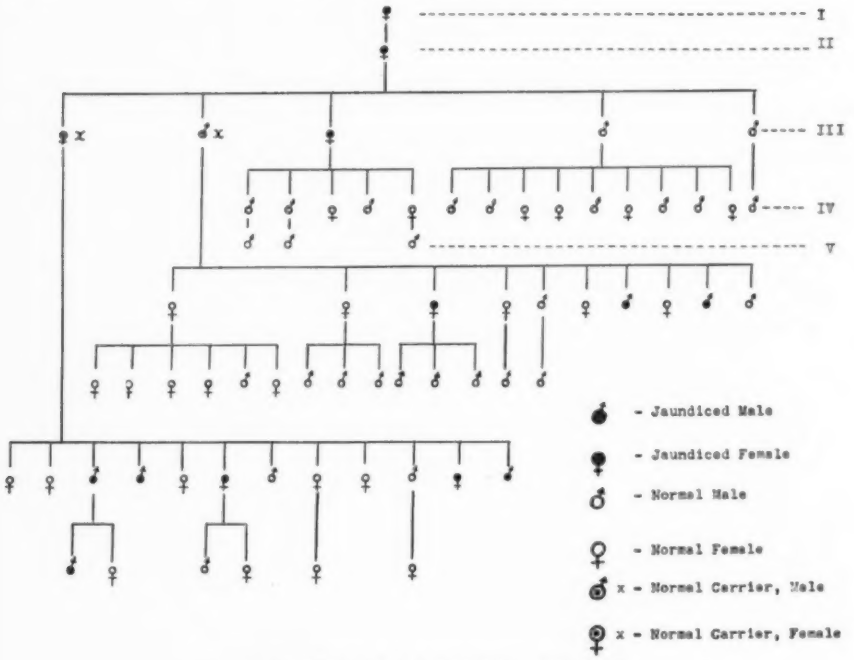
The human form of this malady is sometimes divided into a hereditary and an acquired type, of which the former is more common. The first kind belongs to the inheritable diseases, occurring often in several generations, occasionally in several members of one family without the descendants having the condition,[7] and also in a single member of a family who may be affected from birth. As a result of the precedence of the above findings, the hereditary form in man is often alluded to as the Minkowski-Chauffard type, and the acquired form as that of the Hayman-Widal syndrome.

Definite Inheritance

One of the constant attributes of the rat jaundice is its definite mode of hereditary transmission. Once the jaundiced condition became established, in none of the 249 jaundiced rats which came under observation did any revert to the normal state. An interesting observation however, was that the young with the genetic constitution for jaundice, when born to a normal hybrid mother, were normal at birth and became jaundiced in the course of the next twelve hours or so. Progeny with defective constitutions born to jaundiced dams were yellow at birth.

Reference to data from our rat breeding experiments shows (Table I) that a cross of homozygous normals with jaundiced rats gave rise to hybrid offspring which were definitely normal in appearance. When both parents were jaundiced, however, 100 per cent of the offspring were affected. Normal appear-

*Geneticist at the Dominion Experimental Fox Ranch, Summerside, P.E.I. The author is indebted to Dr. J. W. MacArthur, Professor of Genetics, and to Dr. C. H. Best, Professor of Physiology and Director of the Connaught Laboratories, for aid in the genetical and physiological aspects of the problem.



A PEDIGREE OF JAUNDICE IN MAN

Figure 14

Type of inheritance of jaundice observed in man. Often the defect appears in several consecutive generations, as in dominant inheritance. In other cases several sibs will show the disease, with neither ascendents nor descendents affected, suggesting recessive heredity. After Campbell and Warren.[3]

ing rats (hybrids) mated with jaundiced animals gave rise to mixed litters of normal and jaundiced individuals, in which 113 yellow and 120 normals were produced from 26 litters of such matings, where the expected ratio was 50 per cent normal and 50 per cent jaundiced. Hybrid × hybrid matings produced the largest average number per litter, while the smallest litters resulted from crosses of jaundiced with hybrid animals. Similarly hybrid × hybrid matings are significant of a 25 per cent to 75 per cent ratio.*

"Carriers" Sub-Normal

Although the hybrid rats are normal in appearance, 50 per cent of those tested

*THE CHI-SQUARE TEST FOR GOODNESS OF FIT OF A RATIO

$\chi^2 = \Sigma\ (a - t)^2 / t$

Theoretical frequency of Hybrid to Hybrid matings, 3 normal : 1 jaundiced.

Normal Appearing Rats	Jaundiced Rats	
132	50	Actual Ratio
136.5	45.5	Theoretical Ratio
— 4.5	+ 4.5	

Then $\chi^2 = (4.50)^2 / 136.5 + (4.50)^2 / 45.5 = 0.593$

Degrees of freedom for estimating $\chi^2 = 1$. For $\chi^2 = 0.593$, P = 0.30 to 0.50 and therefore the deviation as observed in the actual ratio would occur in 45 per cent of cases due to chance variation. Thus the actual proportion is a very good fit of a 3 : 1 ratio.

Similarly for a theoretical frequency of normal hybrid rats mated with jaundiced individuals (1 : 1 ratio), for $\chi^2 = 0.208$, P = 0.66 which again is a close fit.

showed an increased fragilty of the erythrocytes and a reticulacytosis. These findings parallel those of "human carriers" of acholuric jaundice, who like the normal appearing hybrid rats can transmit the complete syndrome to their progeny. Such a finding indicates the incomplete nature of dominance in human "Familial Acholuric Jaundice."

Campbell and Warner[1] have a record of acholuric jaundice in five generations of a family, in which two latent carriers were included (*x x* Figure 14). The latter, although normal in appearance upon examination were found to have an increased erythrocyte fragility and also to show slight indications of increased blood breakdown beyond that of normal individuals.

Unlike this disease in man the rat jaundice does not respond to splenectomy. Other attempted therapeutic measures were: treatment with liver extract and whole raw liver, injections of hypertonic and anti-haemolysins. While upon other jaundiced rats liver lobectomies were performed subsequent to splenectomy in an attempt to further reduce the reticulo-endothelial tissue beyond that produced by splenectomy.

None of the above measures removed the jaundiced condition of the mutant rats.

A marked lag in growth was found to be a characteristic feature in the majority of mutant rats. Associated with the latter condition was the presence of marked nervous symptoms, such as a "wobbly gait," or partial paralysis, confined chiefly to the hind limbs. This symptom was particularly manifest in jaundiced animals that were markedly underweight. Experimental evidence indicates that the lag in growth and nervous symptoms are associated with an inability on the part of the jaundiced rats to use carotene as a source of vitamin *A*, and as a result were suffering from a prolonged vitamin *A* deficiency.

New evidence was found in this work for the single gene theory of a syndrome. The chain of symptoms constituting the syndrome in the mutant rats, such as fragility of erythrocytes, bilirubinemia, microcytosis, reticulocytosis, splenomegaly, jaundice and anemia, were only pronounced in young growing animals. This chain of symptoms offers opportunity for study of quantitative effect as well as a variety of qualitative variations from the normal state; all of which probably trace back to a fundamental abnormality of the erythrocyte.

Familial acholuric jaundice in man has usually been associated with metabolic derangements such as albinism, pentosuria, glycosuria, etc., of which Gates[4] says, "In all such cases of inborn deranged metabolism the probable cause is the lack of an enzyme in the absence of which a chemical step is missed and some normal metabolic process fails to take place."

Literature Cited

1. Campbell, J. M. H., and E. C. Warner. *Quart. Jour. Med.*, 19:333. 1925-26.
2. Chauffard, A. *Semaine Med.*, 27:25. 1907.
3. ————————. *Semaine Med.*, 28:49. 1907.
4. Gates, R. R. Heredity in Man. Macmillan Co., New York. 1930.
5. King, H. D., and W. E. Castle. *Proc. Nat. Acad. Sci.*, 21:390. 1935.
6. Minkowski, O. *Verhandl. d. deutch. Kongr. f. inn. Med.*, 18:316. 1900.
7. Tileston, W. *Medicine* 1:353. Detroit. 1922.
8. Widal, F., Abrami and M. Brule. *Presse Med.*, 15:641. 1907.

TABLE 1. RATIOS OF JAUNDICED RATS

Genotypes Male	Female	Number of Litters	Number of young	Jaundiced	Normal	Mendelian Ratio
1. Jj	jj	3	23	0	23	1:0
2. jj	Jj	14	113	0	113	1:0
3. jj	jj	14	96	96	0	1:0
4. Jj	jj	3	25	13	12	1:1
5. jj	Jj	23	190	100	100	1:1
6. Jj	Jj	24	192	59	133	1:3

JJ = Homozygous Normal Rats. Jj = Hybrid Rats. (Normal in appearance)
jj = Jaundiced Mutant Rats.

"PROGRESSIVE HEREDITY" AND "ANTICIPATION"

The Possibility of a Genetic Explanation of Certain Odd Hereditary Phenomena Observed in Man

RICHARD GOLDSCHMIDT
University of California

IN the literature on human heredity, two strange phenomena have been frequently described and discussed as "Progressive Heredity" and "Anticipation." The first term means that a dominant hereditary disease tends to become more extreme in successive generations. The second term indicates that the disease begins to manifest itself at an earlier and still earlier age in subsequent generations. In a general way both these phenomena have been described as a progressive familial degeneration leading frequently to extinction. Among the hereditary diseases which are best known genetically are the diseases of the eye; numerous instances of those two phenomena are quoted in Waardenburg's and Franceschetti's monographs. But also all other groups of hereditary diseases furnish more or less well authenticated examples (e. g. Amaurotic idiocy, Friedreich's ataxia). Geneticists, as a rule, are rather skeptical towards such reports, which seem to contradict the elementary notions of Mendelian heredity. It is therefore silently or openly assumed by non-medical geneticists that the numerous cases of progressive heredity and anticipation found in medical literature are the products of statistically inadequate data, of erroneous diagnosis, of the presence of a combination of different diseases or of similar errors of recording. I am aware of only two attempts to explain such phenomena on a genetic basis. One is given tentatively by Henke and Seeger in the form of a discussion of a number of possibilities, none of which is satisfactory or in accord with accepted genetical facts. The other is proposed by Franceschetti on the basis of my views regarding the relation of gene quantity to time of action of the gene. The aim of the present paper is to show that recent genetic discoveries furnish a basis for the understanding of those phenomena, provided they do actually occur.

The latter point ought to be straightened out first. Though it is highly improbable that all the reports regarding anticipation and progressive heredity are based on error, it must be agreed that the majority of cases have not been studied so thoroughly that all doubt may be dispelled. But there is at least one case which is thoroughly investigated, the case of myotonic dystrophy in a family of Black Forest peasants, studied by Henke and Seeger (and earlier by Fleischer). Here the conditions are favorable to make a clear case: A sedentary family in good circumstances living for generations in the same neighborhood; eight generations with about 3,000 individuals, of whom half were alive when the work was done; clear-cut, easily observed and conspicuous diagnostic phenomena as cataract and muscular atrophy; normal, high birthrate and otherwise good conditions of health; rather constant and favorable environment. In addition the material has been studied with the proper methods and analysed both by the physician and the geneticist. There can be little doubt that here actually those phenomena are present which have been claimed over again in all the other cases, namely: (1) Causation of the disease by what appeared to be a single dominant gene. (2) Very low penetrance and expressivity (in the sense of Timofeeff) of the gene in earlier generations. This

means that only a few of the fifty per cent heterozygous individuals which ought to show the character actually exhibit it, though they can be proved to be carriers (low percentage penetrance); further that those who show the character exhibit only a slight degree, namely, senile cataract without dystrophy. (This means low expressivity.) (3) Increase of the visibly sick heterozygotes up to the expected fifty per cent in later generations. (4) Simultaneous increase in the severity of the symptoms (cataract and dystrophy). (5) Incidence of the disease in younger years, together with its appearance in a more aggravated form, in the later generations.

The *vg* Mutant

The question is now whether all these phenomena are intelligible on the basis of our present genetical knowledge. I think that the clue has been furnished by my recent work on the vestigial wing in Drosophila. The so-called mutant *vg* in Drosophila, usually described as a rudimentation of the wings to small stumps, is actually a hereditary disease, a dystrophy. In a normal wing anlage of a *vg*-fly lysis of wing tissue sets in, which destroys progressively during development the greater part of the wing. There exists a series of multiple alleles of this gene, which produce a different amount of destruction of wing area, beginning with a minute nick at the tip of the wing and leading through all intermediate stages up to almost complete destruction (No-wing-allele). It has been shown that the degree of destruction (phenotype: scalloping) produced by an allele or compound is proportional to the time of onset of the process: late onset in development—little destruction, earlier onset—more and more destruction. The next fact, significant for our object, is that the lower alleles produce a visible effect only in a small percentage of the individuals of the proper genetic constitution; the next higher alleles have a phenotypic expression in a higher percentage of individuals and only from a certain allele on, all individuals show the respective amount of scalloping. (This part of the facts was first analysed by Mohr.) There is a last important point: The *vg*-gene is called recessive. The heterozygotes (vestigial/wild type) are normal. But there exist a number of dominance-modifiers, or dominigenes, which shift dominance towards the vestigial type. Three of these dominigenes are known. If all are present, all individuals are intermediate, i. e., scalloped; if fewer are present, the degree of scalloping and the percentage of such indivduals decreases. Finally it has to be added that the dominigenes alone are practically without effect and that they are present everywhere in Drosophila populations.

Let us take now the last case: a recessive gene (*vg*), causing a dystrophic disease of the wing, acts as an incomplete dominant in the presence of certain dominigenes. This action means that in all heterozygotes the disease (lysis of wing area) sets in at a definite age of the individual (in this case soon after pupation). Let us compare this to the last generation of the human cases with visibility of the disease in all heterozygous individuals, together with a high grade of symptoms and an early beginning of the disease. Now we take the case of a combination of the *vg*-heterozygote with not all the dominigenes: less than 100 per cent of the individuals show the disease (scalloping). The degree is lower, and this is due to a later beginning of the lytic process. Compare this condition to a former generation of the human case: not all heterozygotes are visibly diseased; those who are, exhibit a less extreme degree of disease with incidence in more advanced age. Finally we take the case of the *vg*-heterozygote with the lowest dominigene-combination which still has a visible effect: only a small percentage of individuals show it, these only in a slight degree, which means a very late beginning of the lytic process. Again we compare this with the earlier generations of the human pedigree, where most heterozygous carriers are normal and only a few show the lowest grades of the disease with an incidence very late in life.

Here another point ought to be added.

In the myotonic dystrophy pedigree the low and late grades exhibit only cataract, and only in the severe and early cases the dystrophy appears. In the vestigial case the low members of the series (whatever their genetic basis) exhibit only the lysis of more or less wing area. In the higher members abnormalities of venation, bristles, time of development and viability are added to the wing effect, culminating in homozygous lethality in the No-wing extreme. It is therefore not surprising if, in human cases, additional symptoms appear with earlier incidence. (These and the foregoing facts may throw light upon quite a number of poorly understood phenomena in human inheritance, besides those discussed here.)

The Human Parallel

These parallels between the hereditary diseases of Drosophila and man show that the phenomena of progressive heredity and anticipation would be completely understood if the following were the case:

(1) The gene in question is a recessive one. (2) It is lethal or sublethal in homozygous condition (as is the case with the extreme No-wing allele of vestigial). (3) In heterozygous condition it has no effect (like *vg*) or only a small effect upon a few individuals (like vg^{Nw}). (4) Dominigenes exist which shift the heterozygote towards an intermediate condition, which is visible disease. (5) A series of such dominigenes exist with additive effect, as in the *vg* case. (6) These dominigenes, themselves without visible effect, are present in a haphazard way in the population. (7) The time of incidence of the disease, its severity and the percentage incidence are proportional and caused in an increasing series by the series of additive dominigenes, as in the *vg*-case.

As all these points require no other assumptions than are fulfilled in the vestigial case, the explanation is perfect. The only point which requires an additional assumption is the question why in subsequent generations of human pedigrees dominigenes are accumulated. It seems that with a sufficient amount of distribution of such genes in a population the probability for increase in their number increases whenever one pair has become homozygous by chance. Such an event then would start a series of progressive heredity which otherwise would not occur. This would mean that ordinarily such a disease would exhibit a recessive or only slightly dominant condition. But whenever a mating by chance introduces an accumulation of dominigenes the start is made for a series of progressive heredity. The end of such a line would be either lethality or a slow regressive return to recessiveness by increasing heterozygosity of the dominigenes. But it is not worth while to elaborate the details of such a situation before sufficient exact material is available for a statistical test. The decisive point is: Genetical and developmental systems are actually known which make such odd looking phenomena as progressive heredity and anticipation perfectly intelligible.

Literature Cited

1. Franceschetti, A. Die Vererbung von Augenleiden. Kurzes Handb. d. Opthalmol. 1: 631-855. 1930.

2. Goldschmidt, R. Gen und Ausseneigenschaft. I-II. *Zeitschr. Ind. Abstl.* 69: 38-131. 1935. III. *Biol. Centralbl.* 55: 535-534. 1935.

3. ————. Gene and character. IV-VI. *Univ. Cal. Publ. Zool.* 41 (20-22): 277-312.

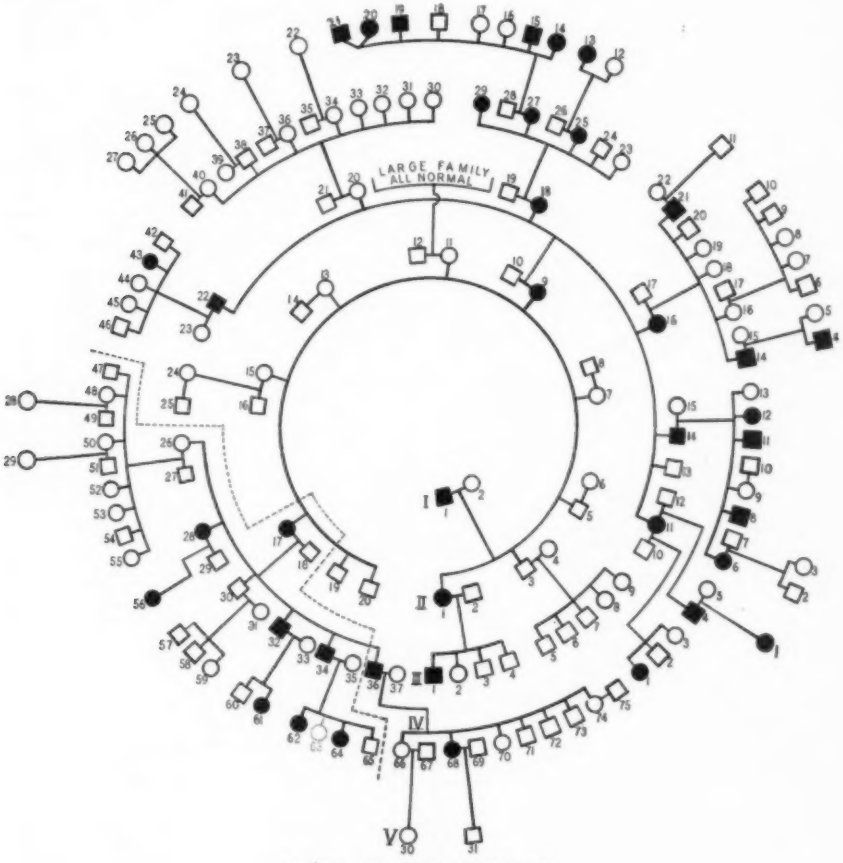
4. Henke, K. and S. Seeger. Progressive Vererbung und Degeneration bei der myotonischen Dystrophie. *Biol. Centralbl.* 47: 727-747. 1927.

5. ————. Ueber die Vererbung der myotonischen Dystrophie. *Ztschr. Konstitutionsl.* 13: 371-415. 1927.

6. Waardenburg, P. J. Das menschliche Auge und seine Erbanlagen. *Bibliogr. Genet.* 7: 1-630. 1932.

FIVE GENERATIONS OF SHORT DIGITS

MABLE R. WALTER



HINTS OF SEX-LINKAGE

Figure 13

In several places in this chart the inheritance simulates that of a sex-linked dominant character, but the pedigree as a whole proves that the apparent association with sex is purely fortuitous. The largest sector in which sex-linked inheritance is suggested is bracketed with a dotted line.

THE accompanying pedigree chart is one of a large family of mountaineers in West Virginia. Most of the data were given to the writer by a member of the clan who was a student at the University of Illinois. Some small fragments of information concerning one branch of the family who had moved away from the original point of settlement were secured by letter. Therefore the data are thought to be very complete since the boy himself is a member of the clan and the family records are quite complete.

The only part of the information which could not be secured but which would have been extremely interesting was facts as to which part of the body

was affected. The boy, true to his ancestral background, refused to state which member of the family had defective fingers or toes, or both. He would only state that in some cases the person afflicted had a few or all short fingers, in other cases a few or all had short toes, and in still other cases, both short fingers and toes.

It is obvious from the pedigree chart that the trait known as brachydactylism, as has been also reported by other workers, seems to be inherited as a simple Mendelian dominant.

It is interesting to note that certain small parts of the pedigree chart indicate a possible case of sex linkage. In the case of IV 4-5 and V 1, the father has passed the trait on to his only daughter. In sex linkage this would be expected since all of the daughters would of necessity be defective. Similarly in the case of IV 21-22 and V 11 if the trait were a simple dominant it might be expected to appear in the one child, but if it were sex linked it would never be passed on from a father to a son.

In the case of III 32-33 and IV 60-61 the inheritance is a perfect example of sex linkage in that the daughter inherits the trait from her father and the son again is normal.

In the case of III 34, 35 and IV 62, 64, 65, if IV 63 were omitted another apparent case of sex linkage would appear. The same would be true in I 1, 2 and II 1-2, 3-4, 5-6, 9-10, 17-18, 19 and 20 if again II 7-8, 11-12, 13-14, and 15-16 were omitted or had not been known.

Of course these cases are far too inadequate to draw the conclusion that sex linkage played any part in determination of inheritance of this trait. In the light of the other overwhelming evidence these isolated cases must be due to chance. But had too few of the family been known and had these apparent sex linked cases formed the bulk of the data available, it would have been easy to fall into such an error and so to interpret them.

Anisfield Award to Elin Anderson

THE third annual John Anisfield prize of $1,000 (established in 1934 for the purpose of encouraging and rewarding the production of good books in the field of racial relationships) has been awarded to Miss Elin L. Anderson for her book "We Americans: A Study of Cleavage in an American City," published by the Harvard University Press.

The list of books from which selection was made this year considerably exceeds that of either previous year in both number and quality. In forming its decision, the Board of judges takes into account first of all certain indispensables, such as high scholarship, literary excellence, and significance of the contribution. Granting these fundamentals, other less tangible qualities are considered, such as readability, clarity, wide appeal, and the probability of reaching a large audience of non-specialists in the matter of race. Taking all these qualities into consideration, Miss Anderson's book is outstanding.

"We Americans" is a sympathetic, but objective, first hand study of the ethnic composition of the city of Burlington, Vermont, and the community problems that result from it. The compact and limited field of investigation makes possible an intensive and somewhat personal investigation of the individual and group relationships and attitudes that develop when representatives of a large number of rather diverse human elements are thrown together in a relatively isolated urban community. A careful perusal of this book will go a long way in helping the reader to understand, and perhaps to participate intelligently in, the problems of assimilation of diverse ethnic elements in any modern community.

This year for the first time an additional award has been offered, in the form of a Grant-in-Aid of $500, to facilitate the completion of a significant research project in the field of race relations. This assistance has been granted to Mr. Guy B. Johnson, research associate and associate professor of sociology, University of North Carolina, in connection with his study of the so-called Croatan Indians of Roseson County, N. C., and their relations with whites and Negroes.

THE INHERITANCE OF DEW CLAWS IN THE DOG

CLYDE E. KEELER AND HARRY C. TRIMBLE*

THE presence of five toes on the hind feet of dogs is observed occasionally. This polydactylous condition in dogs is not the mirrored reduplication of a portion of the paw as is usually the case with cats bearing supernumerary digits. Neither is it due to a bifurcation of digit number five at various levels so commonly found in human hands and feet, nor yet is it due to a splitting of digit number one which occurs rarely in man. On the contrary, the dew claw or extra toe upon the hind feet of dogs represents a true reappearance of the first digit or hallux lost during evolution by most canidae.

Among pedigreed dogs of the fancy it is difficult to obtain evidence as to the occurrence of dew claws; first, because such records are not kept, and secondly, because fanciers in whose stocks dew claws are considered detrimental, clip them off at birth and remain silent about the matter. With the exception of the Pekingese, in which a large, wide foot pad is desired, dew claws are not wanted in most canine breeds, so that the character is a difficult one to study from pedigree records. Selection for the character in the Pekingese breed has continued so long that the breed is probably homozygous for the presence of dew claws.

A Dew-Claw Pedigree

Although it is evident that dew claws have been inherited in some families of dogs, little was known of the exact mode of their transmission. For this reason it appears advisable to place upon record the nature of the inheritance of dew claws as we have observed it among the progeny of a Dalmatian female lacking dew claws which was mated to a Collie male possessing dew claws. (See Figure 16*A*.)

The occurrence of dew claws is denoted by black symbols in the accompanying pedigree chart in which squares and circles indicate males and females respectively.

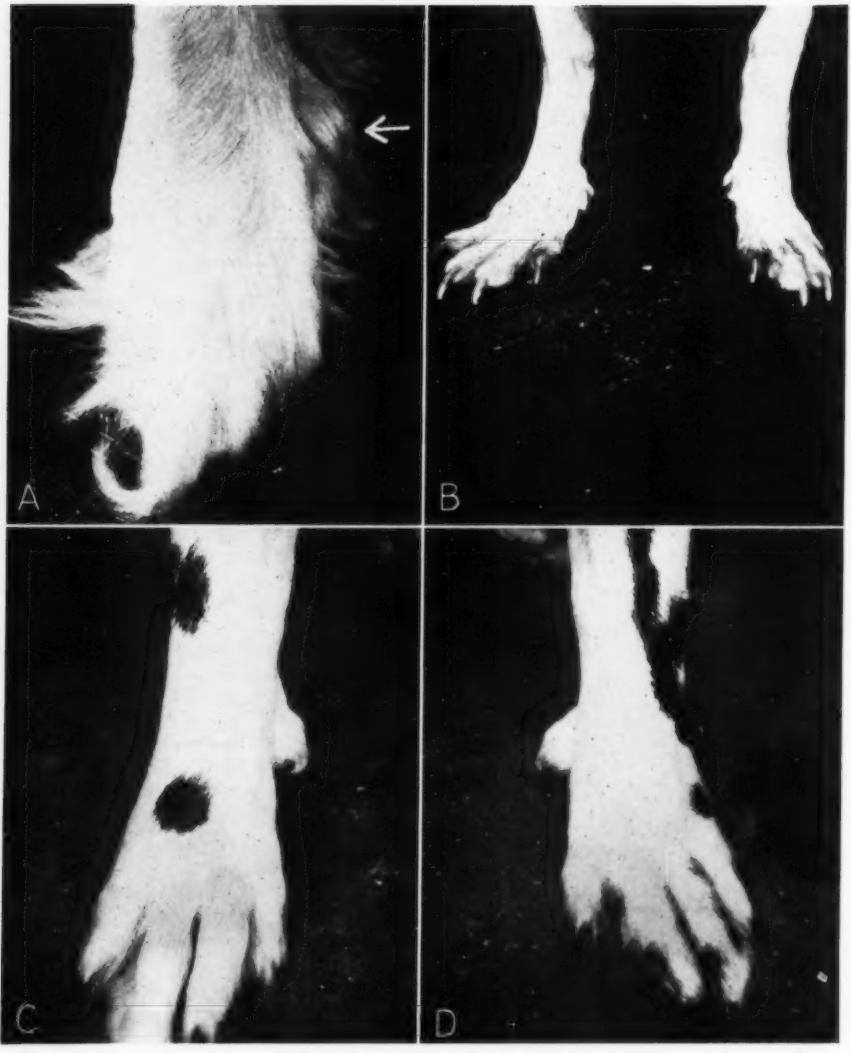
The original cross is represented by the symbols numbered 1 and 2 in the P_1 generation. This mating resulted in the production of one male and four females as shown in the F_1 generation. The F_1 male and three of his sisters had normal hind feet but a fourth sister, F_1-2, had a dew claw on her left hind foot. (See Figure 18.)

The F_1 male was mated to his maternal grandfather's sister who was a pure bred Dalmatian of stock not known to produce dew claws. There resulted from this mating an F_2 litter consisting of two males and two females, all of which possessed normal hind feet. Two of these, F_2-3 and F_2-4, were mated together. They produced an F_3 litter of four males and three females, all of which were normal.

The F_1 female having a single dew claw, F_1-2, was mated to her maternal grandfather. This mating resulted in a litter containing two males and two females. One of the males, F_2-15, (see Figure 16*B*) had dew claws. F_1-2 was mated again, this time to her brother, F_1-1. She gave birth to a litter of eight pups: two males and six females. One male, F_2-12, and three females (F_2-8, F_2-9 and F_2-11) developed dew claws.

F_1-3 was mated to her maternal grandfather and produced two normal females in addition to a female, F_2-17, and a male, F_2-20, having dew claws.

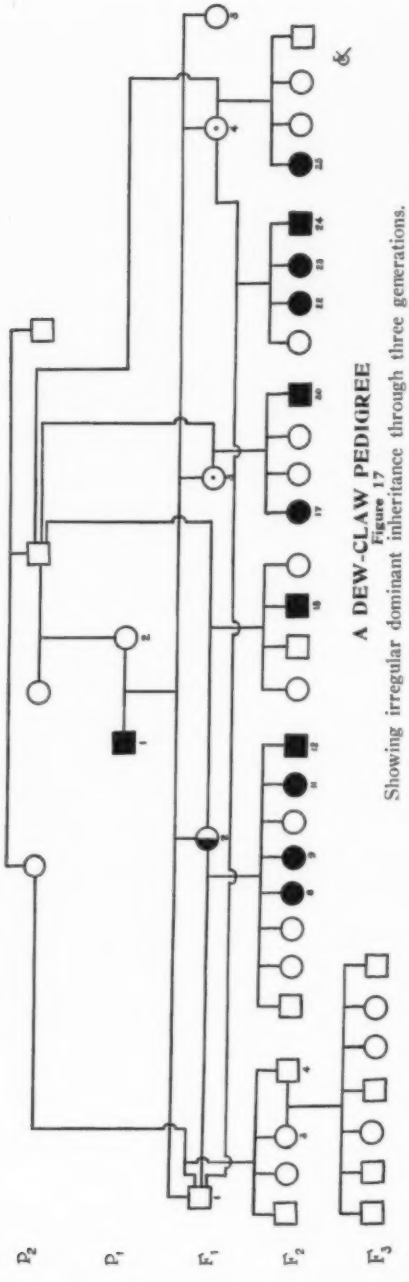
*Howe Laboratory of Ophthalmology and Department of Biological Chemistry, respectively, Harvard Medical School.



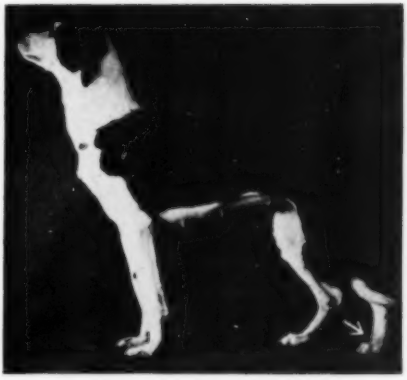
DEW-CLAW TYPES

Figure 16

Feet of dogs shown in pedigree chart (Figure 17): *A*, right hind foot of P_1-1; *B*, hind feet of backcross dog F_2-15; *C-D*, hind feet of backcross bitch F_2-25. The dew-claw is not a reduplication of one of the normal toes, but represents a throw-back development of an ancestral fifth toe, which has been lost in most canidae in the course of evolution.



A DEW-CLAW PEDIGREE
Figure 17
Showing irregular dominant inheritance through three generations.



A SINGLE DEW-CLAW
Figure 18
Dalmatian-Collie bitch with a single dew-claw on the hind leg. While she only had the peculiarity on one foot, she had many offspring with a complete set of extra toes on the hind feet.

F_1-4 by her maternal grandfather, produced a normal male, two normal females, and a female, F_2-25 (see Figure 16*C*) with dew claws, whereas, by her brother F_1-1, she bore a male, F_2-24, and two females (F_1-22 and F_1-23) having dew claws, and in addition she bore a normal female.

From the high percentage of dew claws appearing in the second generation, litters produced both by back-crosses to the non-dew claw breed (Dalmatian) and by crossing together F_1 hybrid dogs, it is certain that the character is often determined by a single mutant gene when present in either one or in two doses; — i.e. in these cases it is dominant in inheritance.

A dew claw developed on one hind foot in individual F_1-2 as we have stated above. This bitch contained but one representation of the gene received from her Collie father, but when she was back-crossed to the non-dew claw Dalmatian stock she transmitted a copy of this gene to her son, F_2-15, which developed dew claws on both hind feet. Hence it is certain that the dew claw gene in simplex may be either completely dominant

or semi-dominant in different individual cases.

However, bitches F_1-3 and F_1-4, although they had normal hind feet themselved, when they were mated to non-dew claw Dalmatian stock, each produced a litter of four pups, one of which had dew claws. Thus it is certain that both of these bitches, although normal footed, carried recessively the gene for dew claws.

Their brother, F_1-1, had normal hind feet, and when backcrossed to the non-dew claw Dalmatian stock became the father of four normal-footed pups. However, the fact that he did not sire any dew-clawed pups among so few offspring does not prove that he was incapable of producing any in this particular type of mating. We cannot be certain of the genetic constitution of his grandchildren, offspring of F_2-3 and F_2-4, because F_1-1 may or may not have transmitted the dew-claw gene recessively to one or both F_2-3 and F_2-4.

But that F_1-1, like F_1-3 and F_1-4, does actually carry the dew-claw gene recessively, is suggested by the fact that when he was mated to his sisters, F_1-2 and F_1-4, there resulted a great increase in the percentage of dew claws in their litters. The litter of F_1-2 contained four pups with dew claws and four with normal feet. That of F_1-4 gave 3 dew claw : 1 normal.

Deficiency of Dew Claws

If we combine all the litters known to contain the dew-claw gene in simplex (hybrid litter of P_1-2, and backcross litters of F_1-1, F_1-2, F_1-3, and F_1-4) we obtain a total of 5 with dew claws : 16 with normal feet. That is to say, where theoretically 50 per cent of the pups carry one dew-claw gene, only 23.8 per cent develop dew claws. In other words, in 47.6 per cent of dogs bearing one gene for dew claws the character will manifest itself.

Both parents contain a single gene for dew claws in the matings of F_1-2 and F_1-4 with their brother F_1-1, (if the latter animal contains it, which seems highly probable). A total of 7 pups had dew claws and 5 were normal, or a proportion of 58.3 per cent dew claws among animals 75 per cent of which carry the dew-claw gene in simplex if not in two doses.

We would expect that all dogs containing two doses of the dew claw gene will develop the character, because animals carrying only one dose develop it in 47.6 per cent of the cases. Thus, theoretically, 25 per cent or 1.75 of the 7 pups showing dew claws were homozygous for the dew-claw gene. The other 5.25 of the animals showing dew claws were heterozygous for the gene out of a possible 6 pups or 50 per cent of the total population of the two litters. By this calculation 87.5 per cent of pups carrying one gene for dew claws develop the character, but it is obvious that the actual numbers involved are too small to yield results of any value other than to serve as the basis for a vague suggestion that possibly heterozygotes may develop dew claws in something over 47.6 per cent of cases.

From our study it is evident that dew claws in the dog is a character having variable dominance, some individuals bearing one dew-claw gene being completely normal, others having one dew claw, and still others having two well-developed dew claws. The character appeared in 47.6 per cent of heterozygotes, and in 58.3 per cent of the F_2 from an outcross to non-dew claw stock.

◆

Genetics Congress Plans

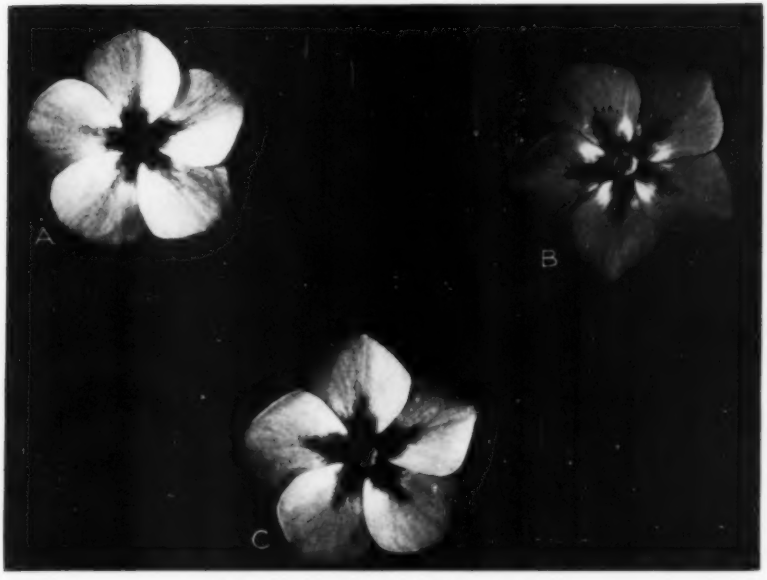
(*Continued from page* 136)

1. What type of accommodation do you prefer—Hotel or Hostel? 2. Will any member of your family be accompanying you? 3. If you wish to participate what may be the title (or general subject) of the paper you propose to submit? 4. What may be the subject of any demonstration or exhibit you may be able to provide? 5. Are you inclined to join the proposed pre-Congress tour?

F. A. E. Crew, Secretary General
Institute of Animal Genetics,
West Mains Road,
Edinburgh, 9,
Scotland.

PICTA PATTERNING IN PHLOX

J. P. Kelly
*The Pennsylvania State College**



PICTA AND UNIFORM PHLOX
Figure 19

A—Picta pattern, with a partially colored petal, the right-hand edge of the petal being white. *B*—Uniformly colored, and *C* pictoid (intermediate) flower types. The latter represents the heterozygote.

SOME foreign seedsmen, such as Gebrüder Dippe of Quedlinburg, offer a type of *Phlox Drummondii* known as *picta*. This is characterized by the kind of anthocyan distribution which is shown in the accompanying photograph (Figure 19). The right third, approximately, of each corolla lobe is white or whitish while the left portion is colored with rose or purplish pigments of medium intensity. The *picta* flower, then, shows a marked radial patterning.

The *picta* phloxes have been called also the quadricolor types. A close glance at a flower might show at the center, throat bars of dahlia purple, followed as one proceeds outward by a blotch or flash of rhodamine purple, then on the left peripheral part might be tyrian rose while the rest of the petal would be white.† But if *picta* be present in a flower lacking central pigmentation the term quadricolor is not a happy one.

A cross section through a young, unopened corolla of Phlox reveals the systematic overlapping of petals that is shown in Figure 20. The light or white portion

*Technical Paper No. 817 of the Penna. Agric. Exp. Station. Of the Botany Department, it is No. 106.

†The color names are those of Ridgway's "Color Standards and Nomenclature."

of each *picta* petal happens to be shaded by the overlapping of an adjoining petal. The appearance of the freshly opened *picta,* therefore, would seem to depend on the degree to which the petal is exposed to light while the corolla is immature. All Phlox varieties have this method of corolla folding but none except *picta* shows such sensitivity to light as a controlling factor in anthocyan development. It is the old story of a special heredity with the proper environment that leads to *picta.*

This influence of light would probably also explain the variability of pattern to be seen among the flowers of one and the same *picta* plant. Long-opened blooms have the white area altered to a light tint due to a general tinting of the flower a purplish or light rose. In classifying a mixed family as to the presence of *picta,* therefore, the freshly opened flowers must be seen to make sure that *picta* is really absent.

PHLOX FLOWER IN SECTION

Figure 20

Enlarged cross section or plan of developing flower bud in Phlox showing location of purplish and white areas in a *picta* flower. The stippling representing purple pigment does not develop in the region not exposed to light.

Genetics of *picta*

When picta enters into any hybrid that is very deep-colored it never shows any of its characteristic radial patterning even when *picta* is introduced through both parents and so must be in homozygous condition. Crossings of two distinct sorts of medium-colored *pictas* led to a reversionary deeply pigmented F_1 of a dozen plants. None of the 12 showed *picta,* i.e., color was uniformly developed on the petals. An F_2 of over 200 individuals included the segregation out of many medium-pigmented plants that were all picta; and as sibs of these were over a hundred plants with aster-purple flowers (deep colored) that revealed no evidence of the homozygous *picta* except in the case of three and in these three the effect was slight. The F_3 descendants of eight aster-purple plants confirm the non-effect of *picta* when present with colors of deepest intensity, i.e., colors referred to as Type I in a previous publication.*

When picta enters into any plant that possesses pigments of medium intensity then it invariably shows if homozygous and very often has intermediate (*pictoid*) effects when heterozygous. Sometimes, though, heterozygous *picta* does not express itself in pigments of medium intensity, i.e., is sometimes recessive.

In analyzing the F_2 data following the crossing of *picta* and *uniform* parents, deep-colored individuals cannot be considered; neither can the white-bladed ones, since *picta* has to have pigments of proper density to reveal itself. A selection among the records from 1931 to 1936, inclusive, reveals 57 F_2 families which yield data summarized below.†

This proves obviously that the simplest Mendelian difference distinguishes the extreme *picta* from the *non-picta* strains of *Phlox Drummondii.*

*See "A genetical study of flower form and flower color in *Phlox Drummondi*" in *Genetics* V: 212-215.

†F_2 families 1-55:— 142 *picta:* 225 *pictoid:* 220 *uniform*
F_2 families 56 and 57:— 11 *picta:* 33 not *picta* (i.e., *pictoid* and *uniform* together)
Total: 153 *picta:* to 478 not strictly *picta*

The F_3 generation is summarized in Tables I, II, and III. In the first table are included all families whose parents were classified by inspection, as intermediate or *pictoid* back in the F_2 generation. In recent years septoria leaf spot has frequently made culturing difficult and some families are small from this or from other causes. Of the 23 families in Table I only those from parents 18 and 19 are not in accord with expectation. The former, 18, was genotypically *picta* which had fluctuated into *pictoid;* the latter, 19, was genotypically *uniform* which had fluctuated toward *pictoid.* Excluding these two families, a summary of the F_3 in Table I shows a ratio of 59 *picta:* 124 *pictoid:* 69 *uniform.*

Table II presents all available data on the F_3 descendants of F_2 plants judged to have been *picta.* Two distinct types of family appeared. Parents 24 to 33, inclusive, gave the expected F_3 offspring on the assumption that *picta* is a homozygous segregate, that is, selfed *picta* in the F_2 gives *picta* in the F_3 with a very small percentage of plants which are *pictas* fluctuating to *pictoid* (see descendants of 28). A second type of family is shown in this table in the progeny of plants 34 to 38. These families have the composition of those from known *pictoid* parents. Plants 34 to 38, therefore, were genotypically *pictoid* but had experienced superficial or fluctuating variation which caused them to be classed as *picta.*

At the bottom of Table I the families from parents 34 to 38 are added to those from other genuinely *pictoid* parents to give a corrected ratio of 82 *picta:* 153 *pictoid:* 80 *uniform* which is a very close approximation to a theoretic postulated 1:2:1 ratio.

Table III gives data on the descendants of plants judged by inspection in the F_2 to have been of *uniform* pigment distribution. Fifteen out of sixteen families came true for *uniform.* The last, No. 54, was undoubtedly a *pictoid* whose pattern had fluctuated to *uniform.* The families from plants 46 and 49 include two F_3 plants ranked *pictoid.* These are considered phenotypic, a superficial patterning not due to the gene for *picta.*

We may designate by the symbols *Pipi* this new pair of allels in *Phlox Drummondii.* The gene *pi* when homozygous causes the *picta* distribution of petal anthocyians of medium or light intensities. Its mate, *Pi* leads to *uniform* distribution of such pigments when homozygous. The heterozygous *Pipi* often conditions an intermediate *pictoid* pattern expression.*

TABLE I - III. Distribution of picta, pictoid and uniform colored flowers in the progeny of certain phlox crosses.

F_2 Plant No.	F_2 parents Phenotype	F_3 Generation Picta	Pictoid	Uniform
1	pictoid	0	1	0
2	"	0	2	0
3	"	0	1	1
4	"	0	3	0
5	"	0	3	0
6	"	1	0	0
7	"	1	0	0
8	"	1	2	0
9	"	0	4	0
10	"	0	2	2
11	"	0	5	1
12	"	7	14	7
13	"	0	1	1
14	"	6	13	7
15	"	1	0	0
16	"	5	16	8
17	"	2	8	0
18	"	10	14	0
19	"	11	0	0
20	"	0	0	0
21	"	4	16	6
22	doubtful pictoid	0	5	4
23	" "	10	20	11
53	" "	0	0	0
Summary counting 18 & 19: 59			124	69
Summary adding 34, 36, 38 37, 38: 82			153	80

Plant 18 genotypically was picta, plant 19 considered as genotypically uniform

TABLE II

Plant No.	F_2 parents Phenotype	F_3 Generation Picta	Pictoid	Uniform
24	picta	2	0	0
25	"	16	0	0
26	"	2	0	0
27	"	26	0	0
28	"	14	0	0
29	"	5	0	0
30	"	3	0	0
31	"	10	0	0
32	"	19	0	0
33	"	2	0	0
34	"	0	3	0
35	"	3	3	3
36	"	11	17	3
37	"	1	0	1
38	"	0	2	1

The F_3 breeding test, thus, shows plants 24 to 33 inclusively to have been genotypically as well as phenotypically picta. Plants 34 to 38 were all pictoid genotypically which fluctuated toward picta.

The families descended from plants 34-38 are counted in with others in Table I to give the ratio of 82 picta: 153 pictoid: 80 uniform.

TABLE III

Plant No.	F_2 parents Phenotype	F_3 Generation Picta	Pictoid	Uniform
39	Uniform	0	0	4
40	"	0	0	5
41	"	0	0	1
42	"	0	0	3
43	"	0	0	4
44	"	0	0	2
45	"	0	0	4
46	"	0	1	11
47	"	0	0	7
48	"	0	0	3
49	"	0	2	10
50	"	0	0	2
51	"	0	0	4
52	"	0	0	2
53	"	0	0	1
54	"	0	2	0

Parents 39-52 genotypically as well as phenotypically uniform.

The two pictoid plants among progeny of 46 and 49 are to be attributed to fluctuating variations.

Plant 54 was most probably pictoid genotypically.

*The author is indebted to Mr. J. D. Moore for cultural care in the face of septoria epidemics and to Dr. L. O. Overholts for the photograph.

OUR TWO INHERITANCES

NEITHER in human nature nor in social relations has progress kept pace with science. This is not the fault of science but rather of man and of society. The great advances in the applications of science have often been used for selfish purposes rather than for social welfare. Scientific progress in medicine and sanitation is far in advance of its social utilization, but not in advance of its urgent need. Rational and peaceful means of solving class conflicts and of preventing wars would be vastly less costly and more effective than strikes and armaments. The fact is that social progress has moved so much slower than science that one might say that scientific progress is matched against social stagnation. Many thoughtful persons are asking: "Will science, which has so largely made our modern civilization, end in destroying it?"

A fundamental fact is that improvements in human nature are not keeping pace with increasing knowledge of and control over outer Nature. By means of language, writing, printing, the radio, and all the means of communication and conservation of knowledge, each human generation transmits its accomplishments to succeeding ones.

Thus present science, culture and civilization represent the accumulated experience and knowledge of all the past, each succeeding generation standing, as it were, on the shoulders of preceding ones. Every individual, on the other hand, begins life where all his ancestors began, namely, in the valley of the germ cells; he then climbs to the summit of maturity and goes down into the valley of death. But society, gifted with continuous life, passes on with giant strides from mountain top to mountain top; and so it happens that science and civilization in general outrun individual heredity, for the learning and acquirements of each generation are not transmitted to succeeding ones through the germ cells but only through social contacts. For this reason increasing knowledge and power have greatly outrun improvements in inherent human nature.

* * *

Although our inherited capacities have not greatly increased since our progenitors rose out of barbarism, yet there has grown up within us an increasing respect for the human mind and a deep conviction of the importance of its freedom. We who are the inheritors of the tradition of liberty of thought, speech and press, and who believe that freedom and responsibility are essential to all progress, should use our utmost influence to see that intellectual freedom shall not perish from the earth. Such freedom has been essential for the advance of science, and the time has come when science should stand for freedom, especially in those countries where force, war and unutterable ferocity are used to compel acceptance of political, social or scientific creeds.

There is no possibility that all men can be made alike in personality, nor any reason why all races and nations should hold the same political and social ideals. But there are good grounds for hoping that they may come to cherish the same fundamental ethical concepts; for the needs and satisfactions, the instincts and emotions of all men are essentially similar. Science is everywhere the same in aims and methods, and this fact greatly strengthens the hope that in a world bound together by science into one neighbourhood there may come to be common ideals regarding fundamental ethics. * * *

The ethics of science regards the search for truth as one of the highest duties of man; it regards noble human character as the finest product of evolution; it considers the service of all mankind as the universal good; it teaches that both human nature and humane nurture may be improved, that reason may overcome unreason, co-operation supplement competition, and the progress of the human race through future ages be promoted by human intelligence and purpose.

In its practical aspects the ethics of science includes everything that concerns human welfare and social relations; it includes eugenics and all possible means of improving human heredity through the discovery and application of the principles of genetics; it is concerned with the best means of attaining and maintaining an optimum population; it includes all those agencies, such as experimental biology and medicine, endocrinology, nutrition and child study, which promise to improve bodies and minds. It includes the many scientific aspects of economics, politics and government; it is concerned especially with education of a kind that establishes habits of rational thinking, generous feeling and courageous doing.

In spite of notable advances of our knowledge of these subjects, we still know too little about human nature and the causes of social disorders. The extension of the methods of experimental science into their study is bound to be one of the major advances of the future, as it has in the field of medicine since the days when human ills were thought to be due to demons. The ills of society have natural causes and they can be cured similarly by controlling those causes.

It has always been true and will continue to be true that knowledge outruns practice and that ideals are better than performance. How can men be induced to live up to the best they know? How can they be brought to substitute the spirit of service for selfishness, love for hate, reason for unreason? The long efforts of past centuries show that there is no rapid solution of this great problem. But in the co-operation of science, education and religion there is hope for the future.—From address by DR. E. G. CONKLIN, as Retiring President of the A. A. A. S., Dec. 28, 1937.

MARRIAGE COUNSELLING IN EUROPEAN COUNTRIES

Its Present Status and Trends

MARIE E. KOPP, PH.D.

THIS newest branch of public health service, the counselling of individuals, couples, and families in marital problems, originated in Europe, and it has virtually been re-originated in recent years. Hence the writer's earlier conclusions[1] based on a study-tour undertaken in the summer of 1932, need to be re-examined in the light of these revolutionary developments. In a recent and more extensive survey both new and old centers were visited in order to trace the shifts in emphasis and scope, which are said to have taken place.

The eugenic point of view dominates the outlook in Germany, Austria, Czechoslovakia and Switzerland, and one finds definite signs of developing eugenic consciousness among the people. In reality the strengthening of the eugenic approach represents a reiteration of earlier policies developed by various municipal and state governments, rather than an entirely original trend. Former subsidies to counselling agencies, operating under official as well as lay auspices, were made to further a general educational program stressing the desirability of improving the mental and physical health of the oncoming generations. In operation, the services, all too obviously facilitated a declining birthrate of a socially more desirable stratum increasingly reluctant to assume the responsibilites of parenthood in the face of insecurity and a lack of confidence in the future. Moreover it became clear, that the prevention of reproduction by presumptive carriers of hereditary defects, the original aim of the marriage and family counselling services, was only very moderately successful, mainly because those most in need of advice did not seek guidance of this kind.

Most European countries are making renewed efforts to enact legislation making a health examination compulsory before marriage and requiring that the certificate of health be a prerequisite to the marriage license. Although it would be preferable to rely upon the voluntary cooperation of the contracting parties, experience has shown that only the more responsible and intelligent elements of the population, who are at the same time the better medical risks for marriage, will cooperate on a voluntary basis. In the majority of countries marriage is prohibited to persons who are manifestly mentally diseased. In many countries, increasing in number, marriage is forbidden to those suffering from venereal diseases until they are discharged from the compulsory treatment required by law. In Sweden the issuance of a marriage licence to feebleminded, deaf-mutes and epileptics is conditional upon pre-nuptial sterilization. In some countries only health certificates issued by a public health official are valid as documentary material to obtain a marriage license, attesting the relative freedom from venereal disease, psychopathy, tuberculosis and physical abnormality. Other countries accept the marriage certification of a licensed physician of good standing in the community. Most countries, however, provide that such medical examination should take place shortly before the application for the marriage license is made, that is, before the posting of the banns. It is held that pre-nuptial medical examination provisions aim especially to reach the women, since they do not come within the scope of any one of the existing voluntary or ob

ligatory health conservation measures for men, such as army medical examinations, or the customary health examinations required for sickness, industrial and life insurance. It will be interesting to watch effects and results of the present legal provisions for voluntary pre-nuptial health examinations in Germany and Austria, where political and social groups encourage the younger elements of the population to accept this as a continual precaution. These medical examinations come under health insurance benefit provisions, which accounts for the fact that many couples do avail themselves of the opportunities. The clerk of the marriage license office may at present withhold the issuance of a license if on reasonable grounds, he suspects the distorting and concealing of important facts. He can ask for a reexamination by the public health official to clear away the doubtful points. To secure a marriage license in a community not the domicile or residence of one of the marriage partners is illegal. The obligatory posting of the banns for a period of at least six weeks before civil marriage can take place, is a further safeguard to protect the community from irresponsible acts of those who do not like to conform.[2]

The German Government decreed[3] that after July 1, 1938, all persons desiring to marry must present physician's certificates attesting to physical and mental fitness for marriage and procreation. Such certificates must be presented to the registrar at the place of domicile, as well as at the place of residence, as an integral part of the documentary material needed for the issuance of a marriage license. The proposed enactment of the law to make pre-nuptial medical examination obligatory indicates that only the more conscientious couples sought pre-nuptial medical advice, while those most unfit for marriage and parenthood could not be reached under the educational and mandatory provisions only.

The European approach to the counselling of individuals, couples and families differs fundamentally from the American attitude toward these functions. In the United States of America[4] marriage counselling to date has in the main been concerned with the solution of the problems related to the psychology and physiology of sex, reproduction, family and social relationships. In Europe, on the other hand, the main objectives are the betterment of the biological stock. To accomplish this purpose, those most unfit for marriage are dissuaded or prevented from marriage and procreation, and those most fit are encouraged to shoulder the responsibilities of parenthood. In short, the American policy seeks to adjust primarily the difficulties of the present generation, while the European policy emphasizes planning for future generations. Eugenic advice, however, is increasingly sought in California, where Dr. Paul Popenoe and Mr. E. S. Gosney have for many years been actively engaged in educational work on eugenics. Counselling in this country is done entirely independently of the public health service. Under private educational, religious, or charitable auspices, it is carried out by the clergy, by educators, psychologists, lawyers and social workers. Only an exceptional physician has interested himself in this broader application of preventive medicine to family welfare. The marriage counsellors in European countries are predominantly physicians, lawyers and clergymen.

The contemporary marital counselling in Germany typifies the new European service in its concern with the biological improvement of its people. The counselling of individuals presenting psychological or socio-medical problems of adjustment, on the other hand, is no longer a major concern of services operating under municipal and state auspices. Such counselling comes now within the domain of specialist's medical services. Under lay and religious auspices religious, ethical and legal advice is provided. The Marriage Health and Racial Hygiene

Bureau—in German, *Ehe und Rassenberatungsstelle*—is not a new venture, as may well be seen from the writer's previous report (See Note 1). It represents a realignment and consolidation of that portion of the Public Health Service which falls within the eugenic ideology.[5] The bureau's major function is education, with its emphasis upon mental and physical health, which is held to be essential for successful marriage and family life. Its program presents a deliberate effort to combat what appeared to be a progressive deterioration of the biological stock of the population. This development is thought to be associated with the widespread family limitation measures: delayed marriage, contraception, abortion and sterilization among the biologically superior elements of the population, and on the other hand, a continuation of reproduction by the biologically less promising elements. The population of the special schools, and of the state institutions for the feebleminded, the insane, the blind, the deaf, and the deformed showed no diminution, while the practice of limiting the family to two children was rapidly becoming a social custom among the upper and middle classes in urban areas, and it was spreading to rural sections also.

In Austria, too, and particularly in Vienna, where the first marriage counselling service was incorporated in the municipal public health activities under the guidance of the late Dr. Julius Tandler, marriage counselling has changed in many respects. At present the municipal counselling services in Austria are in their new alignment more akin to the scope and purpose of family welfare services, as they are known in this country. The counsellor is, however, as formerly, a physician. Outwardly the Public Health Office in the Rathhaus and those in the various city districts, together with its applicants, look much as they did previously. But in reality the former liberalism and breadth of vision for which the pioneer service was famous, have been replaced by more conservative Roman Catholic policies. The *Dispense-Ehe,* a term for the remarriage of a Roman Catholic following a civil divorce, and which was legalized during the liberal regime after the dissolution of the Austrian Empire, was outlawed in 1934 with the amendment of the sections of the Civil Code relating to the remarriage of Roman Catholics. Since the remarriage of a Roman Catholic is technically illegal, the more irresponsible among those who have remarried are able to terminate marriages regarded as illegal by church and state. Difficulties arise from the confusion in regard to the civil status of the former as well as of the present marriage partners. There are also numerous problems of legitimacy, coupled with questions of property rights, alimony, and support of minors. As a result, legal aid is most frequently in demand. Side by side with the municipal counselling services one finds increased activities among the clergy, the various political groups, in the youth movements and adult educational groups. Very extensive work is done by the private counsellors, many of whom adhere to one or another of the psycho-analytical schools.

Switzerland has experienced a real increase in the number of municipally supported marriage and personal counselling bureaus. This development goes hand in hand with the renewed efforts to enact legislation covering compulsory pre-marital medical examination. Counselling carried on under religious auspices has also greatly increased. The most important work has been accomplished by a public education program under the auspices of the outstanding specialists in the various medical disciplines, on civil law and on socio-eugenic topics. Persons needing birth control advice are in all the Swiss marriage counselling services referred to private practitioners or to sickness insurance physicians. For example, in Zurich some 120 physicians have pledged themselves to ren-

der services free of charge to persons "without means" referred by the marriage counselling bureaus. The cost of material for indigents is borne by private charitable enterprise. All counselling services show increased work among the younger group under twenty-five years of age. The most important socio-eugenic pioneer work is done in joint ventures of the departments of psychiatry, gynecology and obstetrics and internal medicine at the universities of Zurich and Basle and Berne.[6] For example, indications for both sterilization and abortion would come under the following categories: medical-therapeutic, if pregnancy or confinement would aggravate existing disease and where complete recovery is not likely to occur; eugenic, for the prevention of physically or mentally defective offspring among hereditarily diseased persons; social-economic, not on economic grounds only, but because a pregnancy makes serious inroads on the physical and mental health of a woman already weakened through poverty, deprivation, etc. Sterilization on eugenic and social indications is gaining adherence among physicians and the authorities because this measure is thought to be less harmful than repeated interruptions of pregnancy in those patients manifesting aversion to further births. This procedure carried out in the presence of a number of persons in the operating room is said to have many advantages over present practices in the private office of the physician or midwife. There is an absence of legal regulations in Switzerland, except in the Canton of Vaud, which enacted laws on sterilization in 1928, and on abortion in 1934.

Efforts at personal and marriage counselling in France at various university centers have been abandoned in the face of apparent preference on the part of the public to receiving such advice from the family physician. There has been little demand for the specialized medical service of premarital examinations and consultations. Although prevalent in other European countries, birth control clinics do not exist in France, Belgium and Switzerland. Contraceptive materials, on the other hand, despite legal prohibitions in some countries are readily available from private physicians, from pharmacists and from rubber goods shops. In general the Belgian situation is patterned upon the French. Sterilization for eugenic reasons has found little favor in France and Belgium; both countries are making definite efforts to raise the birth rate by means of a nationwide family allowance system. In Holland there are approximately a dozen birth control clinics mainly operated unofficially by public health nurses. In addition there are three marriage counselling bureaus, advising on non-medical problems.

The official health and racial hygiene bureau with offices in every community throughout Germany[7] is essentially a project in preventive medicine with the following objectives:

(1) to extend moral and financial aid to those physically and mentally fit to procreate.

(2) to encourage family limitation among those carriers of defective genes who do not come under the provisions of the Sterilization Law of 1933, and among persons whose health has been seriously impaired by disease or accident; or when these conditions would seriously interfere with the well-being of the family and primarily with the welfare of the children.

(3) to prevent procreation by means of sterilization or segregation among those suffering from hereditary types of mental or physical disease agreed to contraindicate reproduction.

(4) Investigation of the family pedigree for couples who have previously given birth to defective offspring on the advisability of further procreation in view of the probability of other hereditarily conditioned defects manifesting themselves.

(5) Investigation of the racial characteristics of the couples in accordance with the German Law of October 18th, 1935, defining approved racial mixtures, and fixing the status of the marriage partners and their offspring on the basis of racial characteristics.

(6) Investigation of and inquiry into the fertility of the marriage partners, because under the Law of 1935, persons judged fecund and biologically fitted for pro-

creation cannot marry persons unable to procreate, be it by virtue of disease or other causal factors.

(7) Investigation of the health, intelligence and pedigree of persons suspected to fall under the provisions of the Sterilization Law of 1933.

(8) Counselling in regard to procreation on the part of persons thought to be carriers of important hereditary defects.

All applicants for civil service posts are compelled to submit to physical examination, much as do applicants for industrial insurance in the United States and other countries. In Germany, Austria and Switzerland, the civil service comprises, in addition all usual federal, state and municipal employees, a majority of the teaching profession and of the clergy. Moreover, applicants for benefits under the large population program, whether for homestead, resettlement, suburban housing settlement, marriage loan, sponsorship by communities of third and fourth babies, must undergo thorough routine examinations of health and heredity.

Applicants are required to give all pertinent data bearing on heredity, both physical and mental, and their present health. These data are assembled as an integral part of the nationwide health census, which has been in progress for several years. The bureau also serves as a clearing house for all information of eugenic importance, much as civil registries do for births, marriages and deaths. Upon the completion of the social and family histories, routine medical examinations are made if no obvious contraindication to marriage has previously been revealed. To the routine medical examination, laboratory analyses, mental tests of the clients' general adaptability to the exigencies of life and a classification by type following Kretschmer's scheme are added. Since no provisions for treatment have been made, defects when revealed in the course of the examination, are treated by the private physician, or by the insurance physician, or in municipal, or state hospital services.

The administrative function of the bureaus may be classified as follows:

(1) Recording and collecting the family histories of the applicant and proposed marriage partner before the publicly announced engagement or even before the formal family arrangement.

(2) Case and family histories are studied to determine fitness or unfitness for marriage and procreation in accordance with the provisions of the Law on Marriage and Racial Hygiene of October 18th, 1935.

(3) The collection of factual material to substantiate the State's contention of the hereditary aspect of a specific disease as against an acquired pathology in cases that presumably come under the provisions of the Sterilization Law of 1933 and subsequent amendments.

The services which were formerly included under marriage counselling in Germany have largely been reallocated. Birth control advice, for example, is given by the out-patient services of the maternity hospitals and by physicians in private practice, with the cost for the materials borne by the sickness insurance funds, as part of the benefits. Contraceptive advice is coming more definitely under strict medical control, since it is held that birth control is a specific type of medical treatment rather than a social hygiene or public health measure in the broadest sense of the word. Control of conception by voluntary means remains an important function for the spacing of births in the interests of the health of the mother and children. Contraceptive materials continue to be manufactured, sold and prescribed in Germany, as well as in other countries, except that intra-uterine devices, little used in America, have been declared harmful and have been prohibited by law. An energetic campaign is now under way to check the house to house peddling of poor and harmful materials sold at exorbitant prices to an ignorant public.

All questions of sterilization of those unfit for procreation on eugenic grounds come now within the province of the District Public Health Office, which acts as the investigating agent. The local Hereditary Health Court

hands down the decisions, and appeal can be made to the Hereditary Courts of Appeals for a final decision.[8] The German Sterilization Law differs on three major points from all other laws enacted to date throughout the world. First, every person manifesting any one of the specified diseases, hereditary in origin, comes under the provisions of the law. Second, it is the only law which specifies definite conditions and diseases which serve as indications for sterilization: hereditary feeblemindedness, schizophrenia, manic-depressive psychosis, hereditary epilepsy, Huntington's chorea, hereditary blindedness and deafness, gross physical deformities and psychopatic addiction to drugs and alcohol. It is therefore in sharp contrast to all other sterilization laws which use such terms as "the insane," "criminals" "morons" "rapists" "imbeciles" and the like. Third, the sterilization proceedings are conducted in strict secrecy and adequate precautions are taken against releasing information to outsiders.

The certification of therapeutically indicated abortion, formerly a function of independent as well as official marriage counselling services, now comes under the provisions of the 1935 Law on Abortion which defines specifically the indications and the procedures for therapeutic and eugenic abortion. Every effort is being made to reduce the practice, formerly extensive, of artificially induced abortions. Criminal prosecution has increased in vigilance, with penalty for the instigator, the perpetrator and the subject. It is believed that the recent increase in the German birthrate is in no small degree attributable to the effectiveness of these measures, as well as to the educational program describing the dangers and ill effects, physiologically and psychologically attendant upon abortion. Abortions for reasons other than eugenic come, as heretofore, under the provisions of the Medical Practice Act. Application for therapeutic abortion must be made by the attending physician to the district public health officer, or to the specifically appointed official of the German Medical Society. Such an application on behalf of the patient must reveal the reasons for such a measure, and such an affidavit must be supported by three independent medical opinions. The decision for abortion on eugenic indications, in cases declared unfit for procreation by virtue of hereditary physical or mental disease rests with the Hereditary Health Courts. The termination of pregnancy on eugenic indications cannot be undertaken if the mother withholds consent. The withholding of the consent, however, for the sterilization operation constitutes no legal barrier to the execution of the law.

Increased attention is given to the manifold problems centering about involuntary sterility in marriage. Sterility clinics have been overburdened with the case of patients who formerly would have made only feeble efforts to solve their problem. Child placing in foster homes with the associated functions of the investigation of the proposed foster home, a thorough investigation of physical and mental health, and the pedigree of the child to be placed as well as the supervision of the foster home, constitute today a part of the services of the marriage consultation bureau.

Efforts are made to assist and protect the illegitimate child and its mother. She is assisted in every possible way during the pregnancy and confinement, and special efforts are made to obtain employment which will enable the mother to keep the child under her own care. In the National Socialist ideology, the woman who carried her illegitimate baby to term is entitled to more respect and consideration than the woman who resorts to abortion for social or for selfish reasons. In Germany, as in most European countries, illegitimate births number from one-tenth to one-sixth of the total births. This large proportion followed from the customs and folkways of land-owninig peasantry, among whom proof of fecun-

dity is often a prerequisite to legal marriage. In rural areas, where the Roman Catholic influence is strong, the illegitimate birth rate is especially high, because of fewer abortions.

The counselling bureau, formerly sponsored by the various German municipalities, and by political, social and commercial groups has ceased to exist. All birth control centers, no matter under what auspices they were operated, closed their doors in 1933. The counselling on personal adjustment problems among the adolescent is now a part of the educational work among the Hitler Youth, both boys and girls, and among the various political party groups, for men and for women. Character development, ethics, sex education and patriotism in the National Socialist sense form an important part of the educational activities, and they are carried on under leadership selected with care. Within the public school system the school physicians are increasingly active, giving periodic health examinations. And there is evidence of extended social service work, greater attention to nutrition, nursing, kindergarten and home economics and other factors of importance to the welfare of the child of school age.

Most of the marriage counselling bureaus functioning under the auspices of religious groups have continued their activities uninterrupted by political changes. From their inception, these bureaus were concerned with religious and ethical questions, while problems of health were referred to physicians' groups or other professionals. Bureaus under the auspices of the Roman Catholic Church increased by 50 per cent during the period from 1932 to 1936. Although it may appear superficially that the Sterilization Law of 1933 was a major factor for the need of extending the service, one may well remember that counselling work under Roman Catholic auspices received its major impetus from national and international congresses which were called by the church leaders in 1932 to outline the functions and the scope of the new field of religious educational activity. From that time onward an increase in agencies fostering marriage between Roman Catholics has been particularly marked. This movement is in accordance with the doctrines laid down in the Papal Proclamations of 1930 and 1931 on Christian Marriage.

Summary

In European countries, and chiefly in the German speaking countries of Central Europe, marriage and personal counselling have gained an important place in the program to raise the biological quality of the population. From its very inception, European marriage counselling stressed measures which might guarantee the well-being of future generations rather than measures directed at the prevention and treatment of physiological and psychological problems of sex and family adjustment.

Many medical services previously rendered by the marriage and sex guidance bureaus are now being given by the maternity divisions of the state and municipal hospitals, under insurance benefits, or in private practice. There have been legal regulations upon sterilization of those unfit for procreation by virtue of hereditary disease and upon abortion for therapeutic and eugenic indications.

There has been a manifest shift in the ethical appraisal of the role and functions of the family. There is a greater emphasis upon the spiritual values associated with the family, the home and motherhood than at any time previous to the World War, which left in its wake a materialistic ethics and an excessive individualism.

With the incorporation of many phases of marriage counselling into the public health service, marriage counselling is assuming greater importance for the social and biological welfare. It is now possible to develop and to carry out long range plans of definite eugenic implications, and to support them with public funds.

Literature Cited

1. KOPP, MARIE E. The Development of Marriage Consultation Centers as a New Field of Social Medicine. *Am. Jour. Obstet and Gyn.* XXVI, No. 1, 26:(1) 122. 1935.

2. GUETT, LINDEN UND MASSFELLER — Blutschutz und Ehegesundheitsgesetz. J. F. Lehmanns Verlag, München. 1936.

3. Report in the *New York World Telegram*, Nov. 9th, 1937.

4. National Council of Parent Education. Marriage and Family Counselling. *Parent Education*, Vol. III, No. 1 and No. 2, 1936.

5. GUETT, ARTHUR, Grundsaetze fuer die Errichtung und Taetigkeit der Beratungsstellen fuer Erb—und Rassenpflege. Erlass des Reichs—und Preussischen Ministerium des Inneren.

6. ROLLIN, BERNARD. Schwangerschaftsunterbrechung und Sterilization. Dissertation Universitaet. Zuerich, 1935.

7. KOPP, MARIE E. The Nature and Operation of the German Eugenical Program. *Marriage Hygiene.* Vol. 4, No. 4. May, 1937.

8. KOPP, MARIE E. Legal and Medical Aspects of Eugenic Sterilization in Germany. American Eugenics. American Eugenics Society. New York, N. Y., 1936.

◆

SPECIES HYBRIDS IN SUGAR-CANE

Hybridization in and with the genus *Saccharum* formed the topic of Rao Bahadur T. S. Venkatraman's presidential address to the Section of Agriculture. Hybridization in the sugar-cane at the Imperial Sugar-cane Station at Coimbatore represents the first attempt to improve the subtropical types of canes. This genetical work, which has been going on at the Station for more than twenty-five years, has involved six species of *Saccharum* and four genera. There appear to be two distinct groups of wild species of *Saccharum*, both of which are confined to south-east Asia. Some of the wild species show wide variations. For example, a survey of the Indian wild species, *S. spontaneum*, showed a variation in sugar content of the juice from 0-5 per cent to 17-0 per cent, the latter figure being higher than that of certain cultivated Indian canes.

The Indian canes belonging to the species *S. barberi* are cultivated in subtropical India, though some are found farther south. Certain Indian canes cannot be ascribed to the genus *Saccharum*, the most important being the Mungo group of Dr. Barber.

A wide range of forms is known to arise from sugar-cane seed. This is explained by the heterozygous nature of the parents and the fact that most sugar-canes in cultivation are polyploid; for example, *S. officinarum* is octoploid.

Very little in-breeding has taken place in the sugar-cane, but much work has been done on inter-varietal, inter-specific and even inter-generic hybridization. Inter-varietal hybridization has been confined mostly to *S. officinarum*. At Coimbatore, economically important inter-specific hybrids have been obtained from *S. officinarum* × *S. spontaneum*. In Australia and Hawaii, *S. robustum* is being used for producing hardier seedlings for tropical regions.

At Coimbatore, inter-generic hybridization has been carried out, using such genera as *Sorghum* and *Bambusa*. The *Sorghum* cross was introduced to produce a shorter life-cycle which in the sugar-cane is from twelve to even twenty-four months. Hybrids producing a crop in seven months have been produced, and these have had high quality juices. Growth vigour in these, however, has proved disappointing. Crossing with the bamboo (*Bambusa*) has been introduced in order to obtain greater vigour, but experimental work has not proceeded far enough yet to justify definite conclusions, from the economic point of view.

The previously mentioned inter-generic hybrids have shown some interesting phenomena with regard to the manner in which the characters are shown in the F_1 generation and transmitted in further backcrosses with either parent. In both the *Sorghum* and *Bambusa* hybrids with sugar-cane, the one fact that stands out prominently is the general dominance of *Saccharum* characters in the F_1 generation.

In the case of *Saccharum* × *Sorghum* hybrids, the general dominance of *Saccharum* characters was found to persist even after twice back-crossing the hybrids with their *Sorghum* parent. Certain of the *Sorghum* hybrids exhibited morphological characters not found in either parent. Most of these hybrids were infertile in their first generation. On further vegetative propagation, however, some of them are showing an increasing fertility in the sexual organs with the result that, whereas in the earlier years no seeds could be obtained from these, it has since been possible to raise seedlings in large numbers from some of them and also to back-cross them with the two parents.—*Nature*, Feb. 19, 1938, p. 340.

A new, revised edition of a standard introductory text

GENETICS

By Herbert Eugene Walter

will be published this spring

Professor Walter has entirely rewritten large portions of this book in order to incorporate important new developments in genetics and to improve wherever possible the value of the book as an introductory text. Extensive new material in the first part of the book explains the five main avenues of approach to the study of genetics—the observational, experimental, statistical, cytological, and developmental. A new section at the end of the book discusses important problems in eugenics. The whole book provides an excellent general survey of genetics—its established principles and the main lines along which modern investigation is now being done. $3.25 (probable)

MACMILLAN

60 Fifth Avenue New York

THE LIFE, LETTERS AND LABOURS OF

FRANCIS GALTON

BY KARL PEARSON

Four large volumes (11 in. by 8 in.)
182 full-page plates, some in color.

Previously $59.40—Now $39.00

THIS magnificent biography by one great man of science about another, has been compared with Boswell's Johnson and Trevelyan's Macaulay. It is a full record of a life of amazing diversity, luxuriously printed by the Cambridge University Press. Galton's pioneering work in biometry, psychology, anthropology, genetics, eugenics and human biology to a large extent constitutes the source of our modern interest in these subjects, so important to the future of the race. Here is an account in good measure of the man's many-sided activities and of his speculations on everything with which he came in touch.

The books contain much material tracing the heredity of the Galton and Darwin families. These volumes are of absorbing interest to any scientist, and particularly to any student of heredity.

> *"It was certainly fitting that the life of the greatest exponent of heredity should be written by his great disciple, and it is gratifying indeed to find that he has made of it what may without exaggeration be termed a great book."*
>
> —DAILY TELEGRAPH

"A wholly worthy memorial of a very great man."

—SCIENCE

Readers of "The Journal of Heredity" are particularly invited to take advantage of the reduced price.

CAMBRIDGE UNIVERSITY PRESS

The Macmillan Company, 60 Fifth Avenue, New York